1977 SPC PRES-- GENE HELMS

Prelim Cy # 11 Gene Kremer

TEXAS INSTRUMENTS INCORPORATED

SPC '77

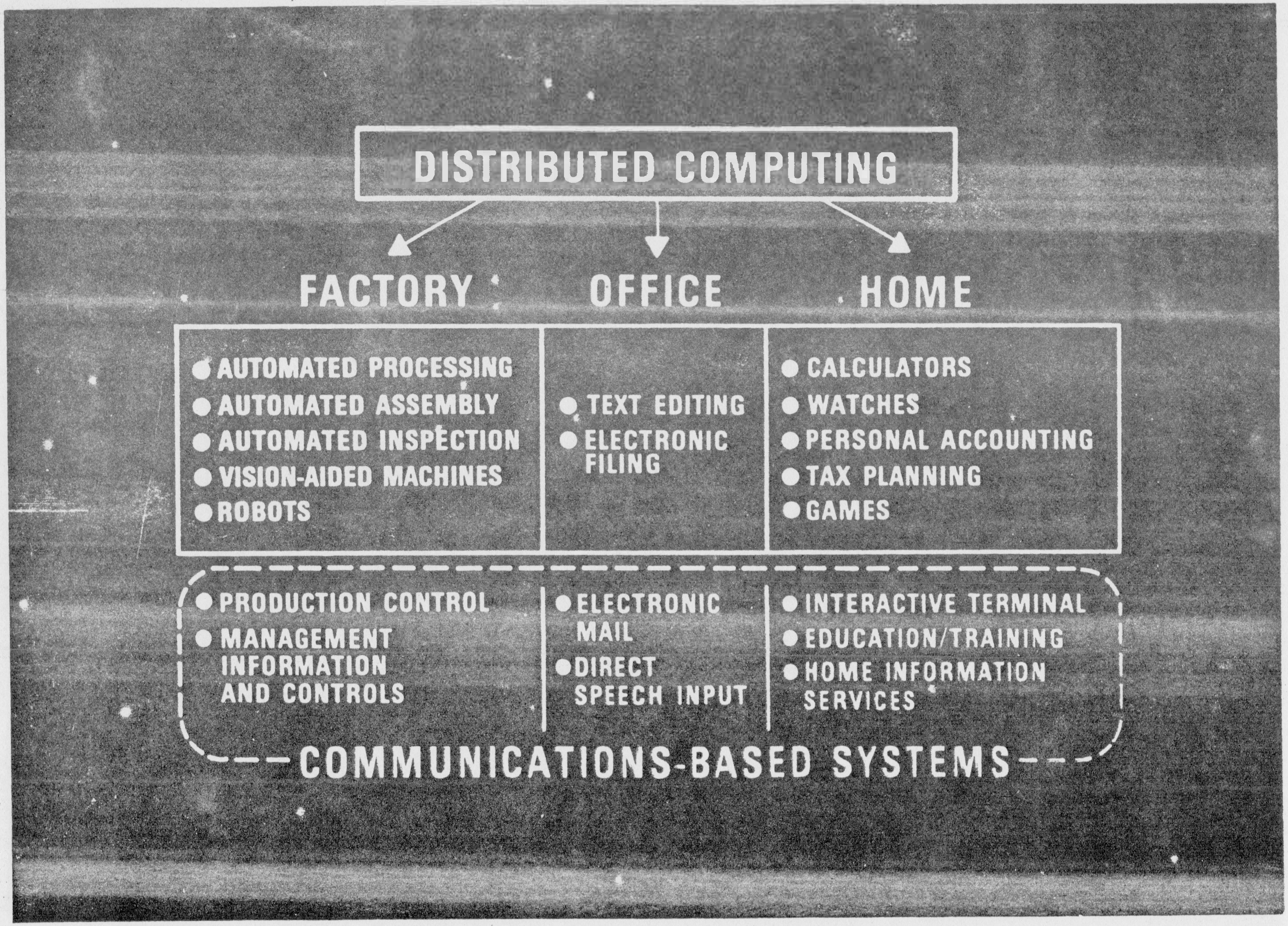
STRATEGIC PLANNING CONFERENCE

MARCH 21-24, 1977

Distributed Computing

Gene Helms

3-23-77


DISTRIBUTED COMPUTING
FACTORY
OFFICE
HOME
AUTOMATED PROCESSING
AUTOMATED ASSEMBLY
AUTOMATED INSPECTION
VISION-AIDED MACHINES
ROBOTS
TEXT EDITING
ELECTRONIC FILING
CALCULATORS
WATCHES
PERSONAL ACCOUNTING
TAX PLANNING
GAMES
PRODUCTION CONTROL
MANAGEMENT INFORMATION AND CONTROLS
ELECTRONIC MAIL
DIRECT SPEECH INPUT
INTERACTIVE TERMINAL
EDUCATION/TRAINING
HOME INFORMATION SERVICES
COMMUNICATIONS-BASED SYSTEMS

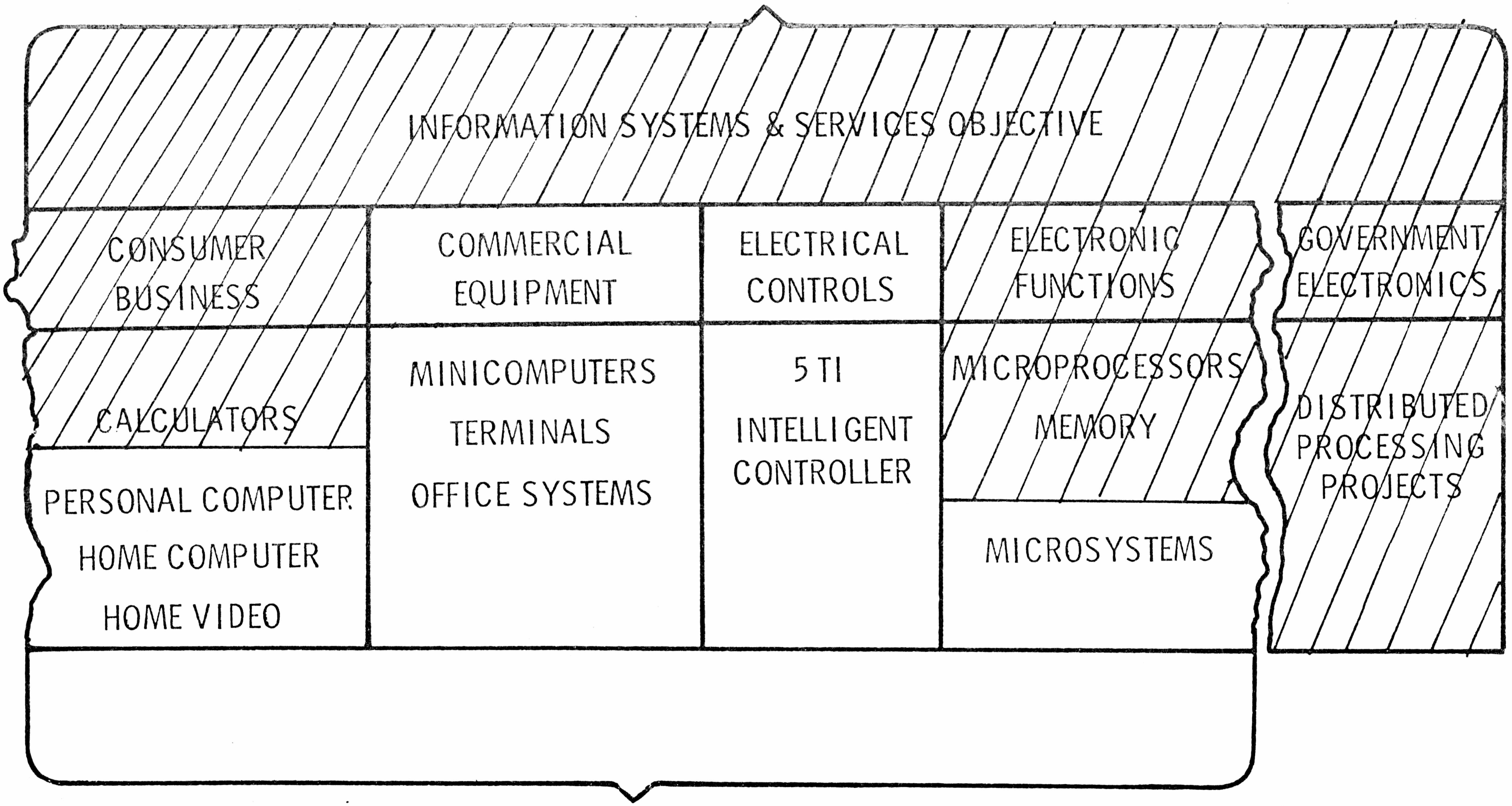
DISTRIBUTED COMPUTING

Slide 1:

Distributed computing is one of TI's three major growth thrusts. It is based on our opportunity to serve industry, the office, and the home with computing and communications based systems.

DISTRIBUTED COMPUTING
SCOPE

STRATEGIC COORDINATION & SHARED EXPERIENCE



DISTRIBUTED COMPUTING MARKET & FINANCIAL GOALS

Slide 2:

Our present distributed computing activities span these five business objectives plus Information Systems & Services, giving us extensive opportunities for shared experience, and need for careful strategic coordination. The strategies highlighted are those counted in establishing the distributed computing marketing and growth goals. Note that personal and home computers are included, but not calculators. Likewise, microsystems, or board-level microcomputers are counted, but not microprocessor components. Although we'll talk a great deal today about the Commercial Equipment Business Objective, Distributed Computing comprehends major contributions from the other organizations as well.

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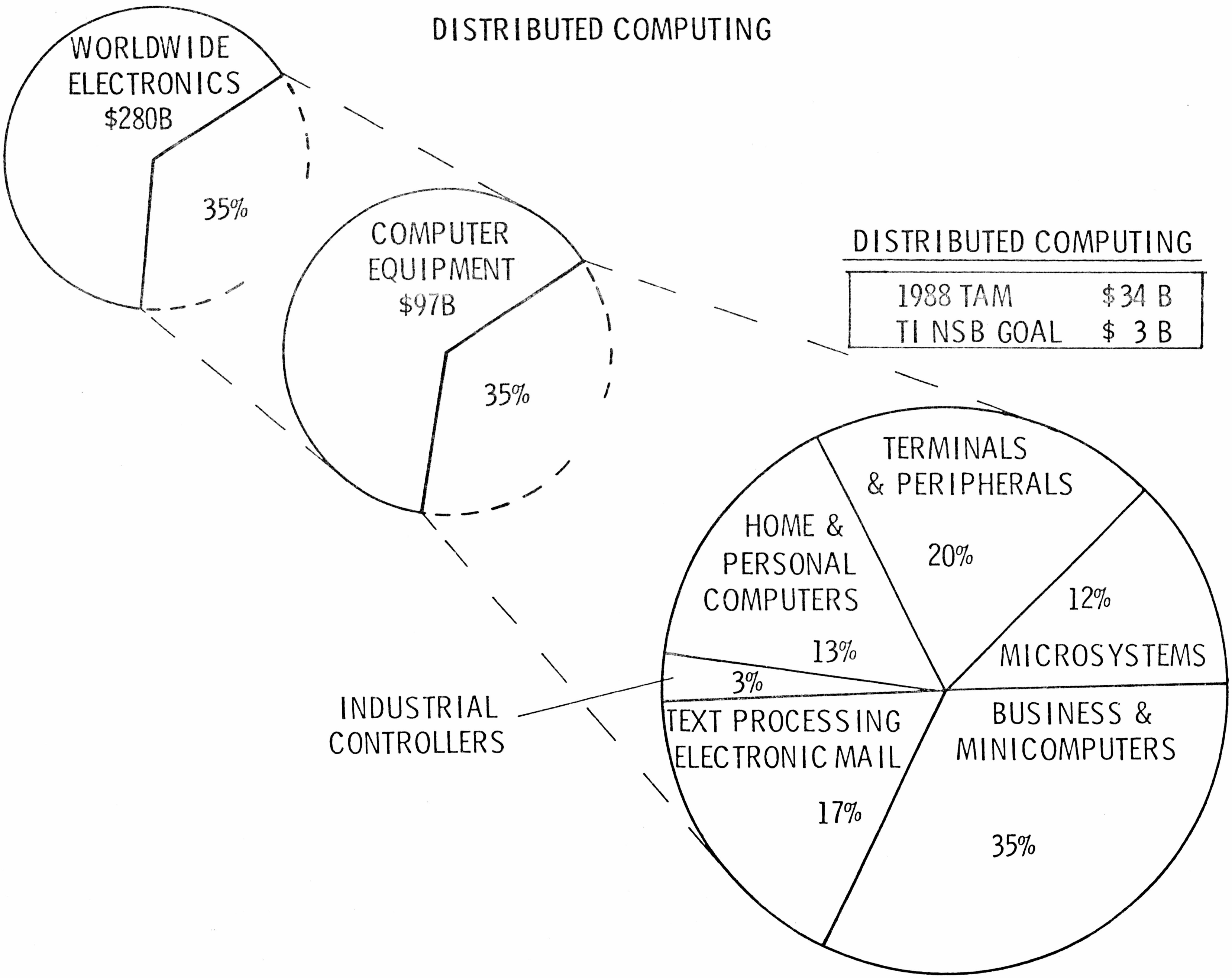

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1988 TAM	$34 B
TI NSB GOAL	$ 3 B

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Slide 3:

In the 1988 worldwide electronics market, $97 B will be in computer equipment and related software. Our opportunity is in the distributed computing portion, estimated at $34 billion. This is up from $28 billion estimated a year ago, primarily due to personal and home computers, not included in that earlier estimate. Our goal is for distributed computing to contribute $3 billion, at model profitability, toward TI's goal of $10 billion in the late 1980's. How do we get there?

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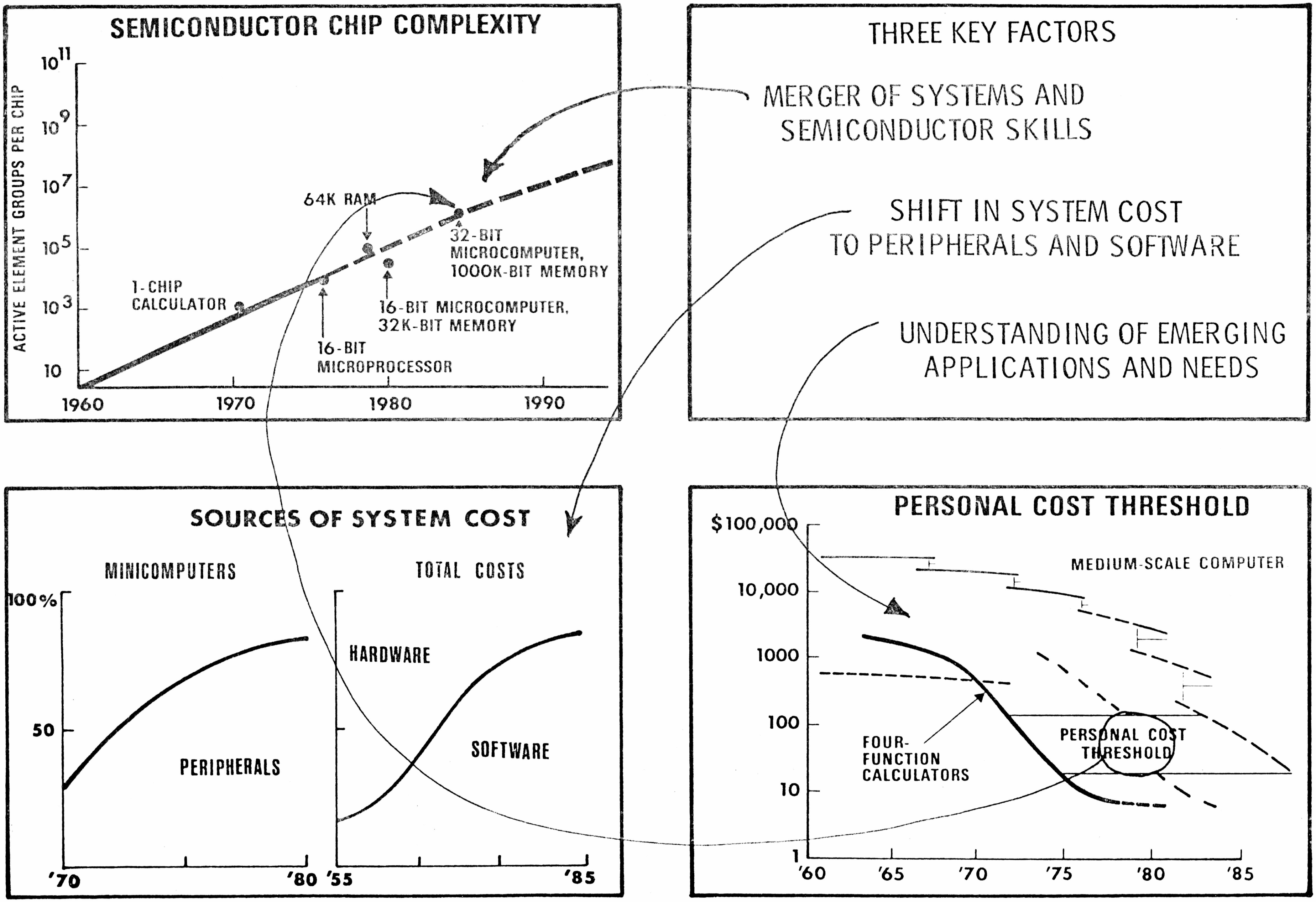

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Slide 4:

There are three factors that I believe are so important that, if we really understood and executed them, we would be virtually assured of success.

The first is the need for effective merging of our systems and semiconductor skills. The staggering projections of chip complexities equivalent to a 32-bit computer with a megabit memory absolutely require it. And TI has the resources to merge these disciplines as very few other organizations in the world could.

Second is the shift in total system cost toward peripherals and software. Given even an outstanding success on the first issue, advances in logic and memory systems will not be decisive in attaining our distributed computing goals. Necessary, but not sufficient. Even the expected shift of some software functions to hardware will not reverse the decisive role of software and peripheral costs in system-level decisions.

Third is the understanding of emerging applications and needs. Major successes on the first two issues can be wasted if we fail to anticipate the opportunities correctly, and with sufficient lead-time. The prospect of an IBM-1800 type capability crossing the personal cost threshold by 1988 illustrates this dramatically. This is totally a technology-driven trend. Few can even imagine the need for such capability at the personal level. Yet, even more significantly, some more moderate, but still remarkable capability will enter this threshold region in the early 1980's. What is the need it will match, which, once understood, would provide the need-pull and lead-time to gain a leading position, and to earn the profits accorded to leading products?

Such insight would help us close the loop, back through the software and hardware stages, providing guidance and direction for the complex semiconductor functions of the 1980's.

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THREE KEY QUESTIONS

CAN WE EFFECTIVELY MERGE SYSTEMS AND SEMICONDUCTOR DISCIPLINES FOR TOMORROW'S CHIP FUNCTIONS?

CAN WE DEVELOP AN ADEQUATE FAMILY OF SYSTEM ELEMENTS, INCLUDING SOFTWARE AND PERIPHERALS?

CAN WE RECOGNIZE AND ACT UPON EMERGING OPPORTUNITIES EARLY ENOUGH?

Slide 5:

Let's recap.

Can we effectively merge systems and semiconductor disciplines for tomorrow's chip functions?

Can we develop an adequate family of system elements, including software and peripherals?

Can we recognize and act upon emerging opportunities early enough?

These three questions are so vital that we must consider how well our strategies satisfy them.

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STRATEGY LEVELS

APPLICATIONS ORIENTATION → STRATEGY LEVEL C

- PROBLEM SOLUTION
- SYSTEM INTEGRATION
- APPLICATION SOFTWARE
- SERVICE AND SUPPORT

MANUFACTURING ORIENTATION → STRATEGY LEVEL B

- COMMON HARDWARE
- OPERATING SYSTEMS
- PACKAGED SYSTEMS
- OEM MARKETING

SEMICONDUCTOR ORIENTATION → STRATEGY LEVEL A

- VOLUME MANUFACTURING
- UPWARD INTEGRATION
- LEVERAGE OF LOGIC AND MEMORY

Slide 6:

The three questions correspond to strategy levels A, B, and C. C stresses the application: problem solution, application software, and end-user service. B stresses the family of system elements, the tools of the trade, and their manufacturing economics. A stresses the semiconductor orientation, where logic and memory can be decisive, and upward integration is a continual result of progress.

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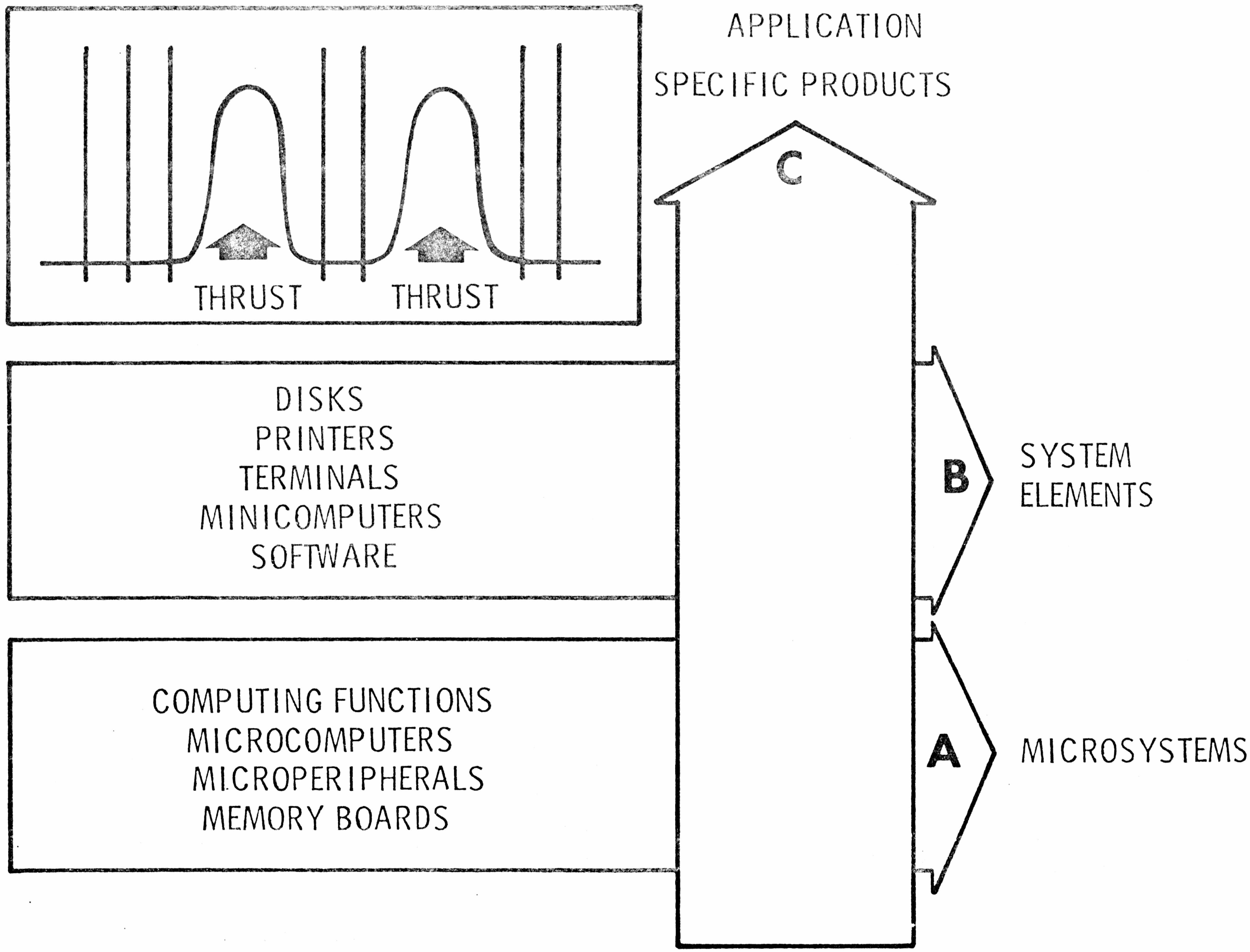
STRATEGY LEVELS



Slide 7:

Strategy level A, Microsystems, is where we must achieve the merger of our systems and semiconductor skills. Strategy level B, System Elements, is where most of DSD is today. Both A and B have a horizontal orientation because they strive for commonality -- commonality across a number of market segments -- the more the better for volume and manufacturing economy. Strategy level C, on the other hand, stresses specialization, not commonality. In application specific products, it has a vertical orientation, striving to segment the market along some basic industry, application, or functional boundary leading to a specialized body of know-how, and affording a defensible barrier. It draws its building blocks from the A and B levels.

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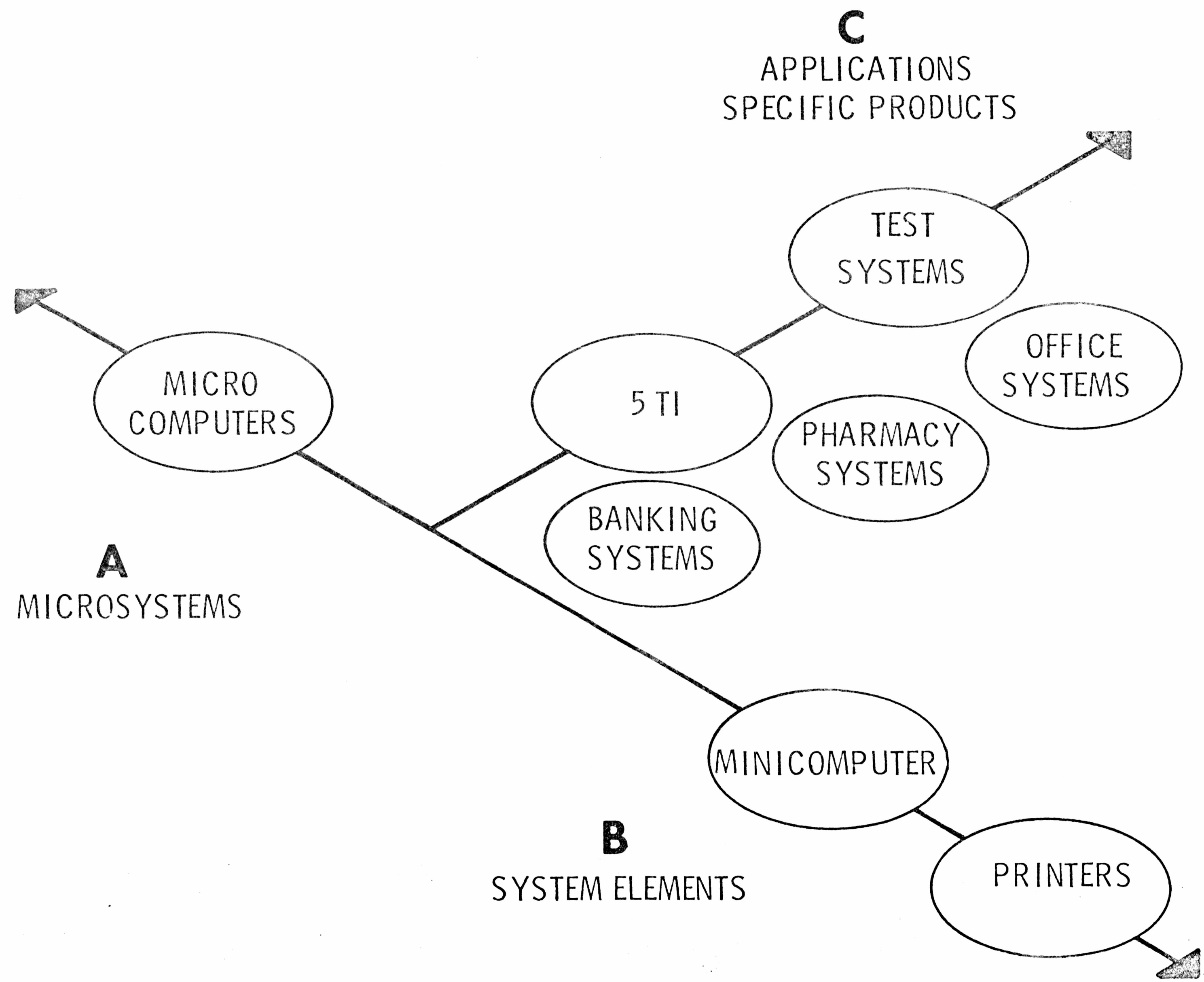
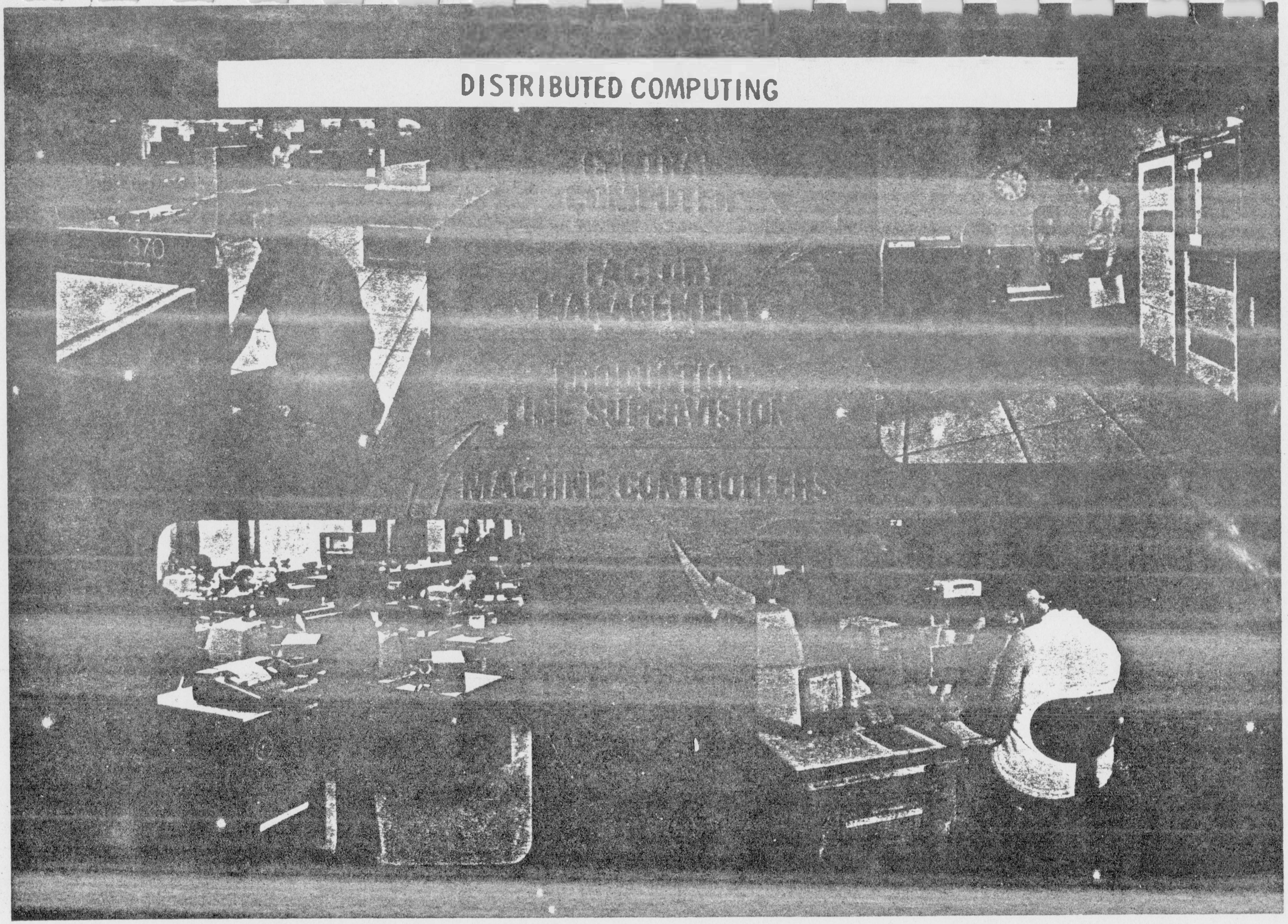


Slide 8:

Some products are not pure B's or C's, but possess attributes of both. Printed circuit board test systems, and the 5TI industrial controller are examples of nearly pure C's: application specific products. Minicomputers and printers are pure B's. The pharmacy system recently announced is a mixture: it draws on essentially standard hardware at the B level, but it couldn't have happened without application specific marketing know-how, leading to a minor but essential tailoring of the product. In such cases, the B/C boundary can be blurred. The important thing is not what to call it, but the discipline of thinking through the right combination of standardization versus specialization for each product.

I want to use these ABC strategy levels to map some trends and strategies, but first we need to review the hierarchy levels of distributed computing.



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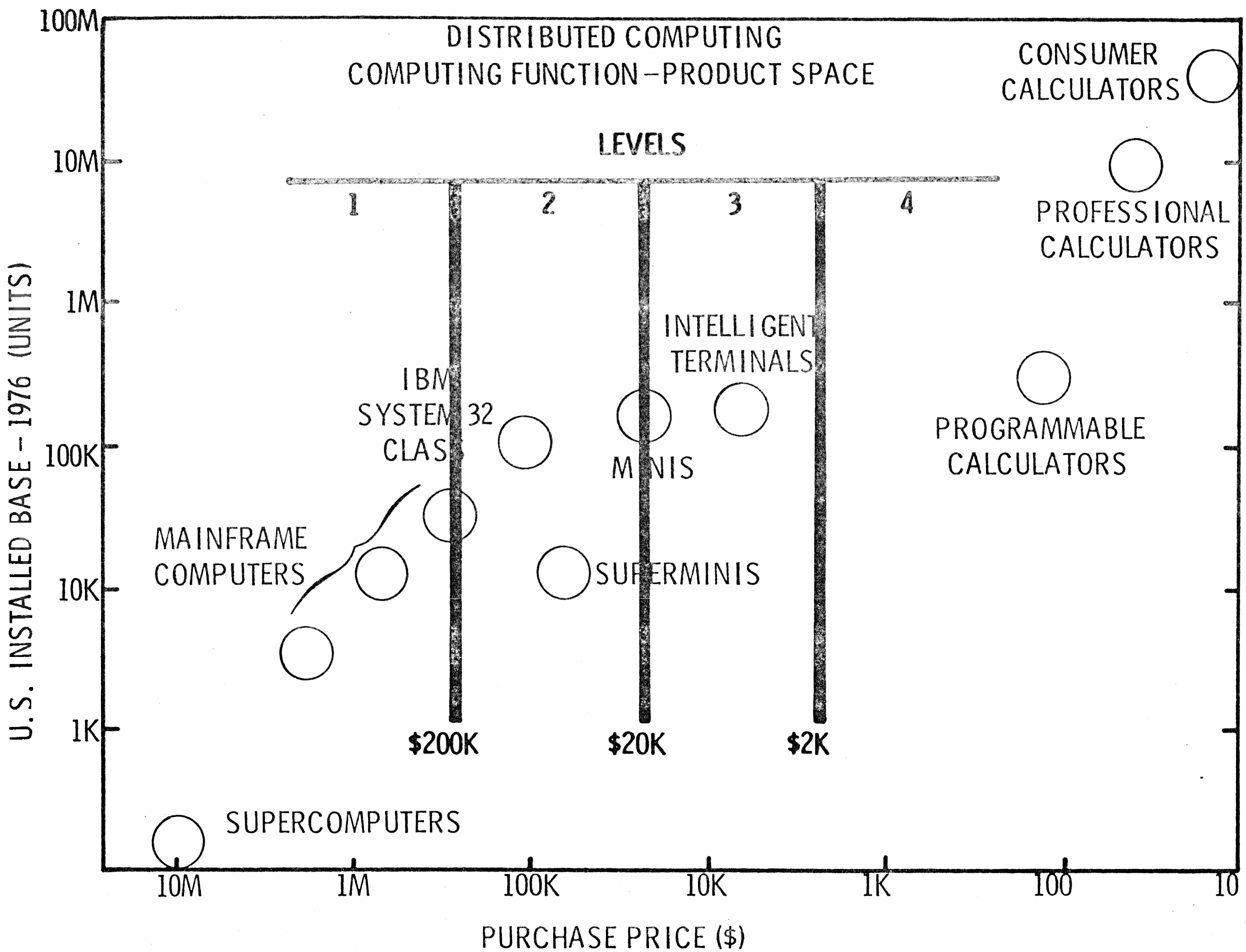
Slide 9:

Last year we discussed the four levels in a typical distributed processing hierarchy at TI. It was stressed that the levels were not always distinct, and that the number four contained no magic. It is now clearer that level of interconnection in a network is not so significant as the performance/cost characteristics of the function being performed.



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Slide 10:

The definition and interpretation of these levels takes on more significance when we examine typical products in the function/product space. This is the same format discussed by Jim Fischer on Monday. Here, we have chosen the boundaries, somewhat arbitrarily, at $2K, $20K, and $200K. This places most mainframes in Level 1, and calculators, including programmable models, in Level 4. Intelligent terminals fall in Level 3, and super minicomputers in Level 2.

The Level 4 boundary at $2K falls in a natural gap where few products exist today. It also corresponds to the boundary between DSD to the left, and both consumer and semiconductor to the right. The 990/2, now shown, falls in Level 4 and has been designated a Semiconductor Group responsibility in the Microsystems thrust.

Now, let's put these functional levels together with the ABC strategies,

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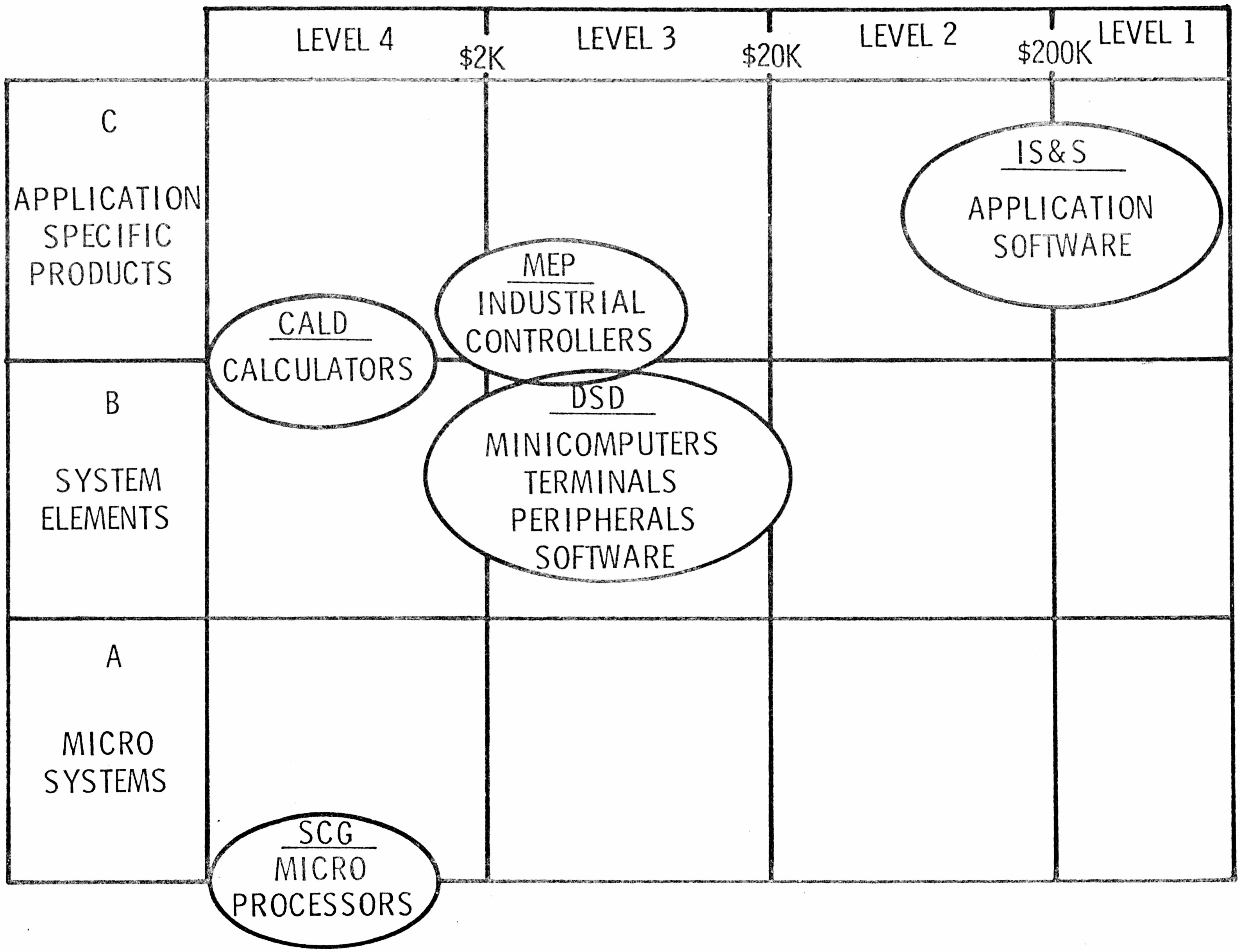
TI STATUS



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Slide 11:

The vertical dimension represents the ABC strategy levels and is market-oriented; moving up, you get closer to applications and the end user; downward, you approach the component level. Functional levels are represented horizontally and are price and performance oriented, with

the largest systems on the right, smallest at the left. Upward and to the right is the large end user system, like TI's Corporate Information Center, and the IS&S organization shown. Down and to the left are microprocessors. The top left is calculators: application specific, end-user products, but relatively simple and very low-cost. DSD-s principal strength is in the B-3 sector, with some modest thrusts upward to the C level. The application specific nature of the 5TI controller puts it in sectors C-3 and C-4. Now, let's speculate for a moment what this map will look like in 1988.

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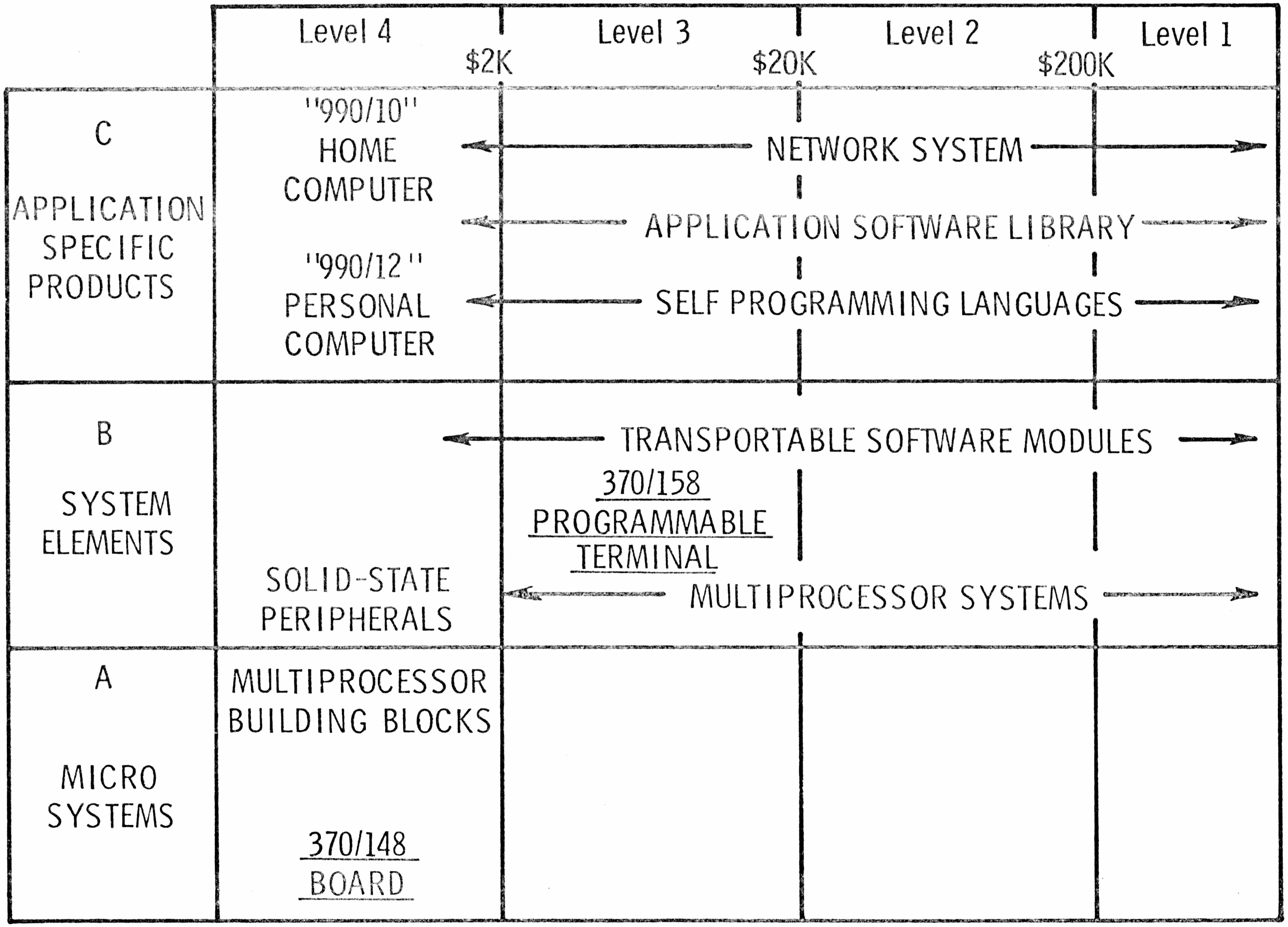
1988 MARKET SCENARIO



Slide 12:

Let's start at the lower left and put in the equivalent of an IBM 370/148 on a board. Also multiprocessor building blocks of similar power, modularly expandable.

Moving up to the B level, multiprocessor systems span the range out to supercomputer functions. Transportable software modules span hardware generations. Solid-state peripherals bring the learning curve to displays, printers, and mass memory. And, where DSD maps today, something like an IBM 370/158 packaged as a programmable terminal will be possible.

Personal and home computers will exist in great volume with capabilities comparable to 990/10's and 990/12's. Across the entire application spectrum, the decisive factors will be widespread communication networks, applications software libraries, and advances in programming ease.

Every sector must continually stretch for more power and capability just to hold its place. Functions are migrating from right to left, and also downward. Every sector can, to some extent, see its future by looking up and to the right. But let's try to nail down this migration more specifically.

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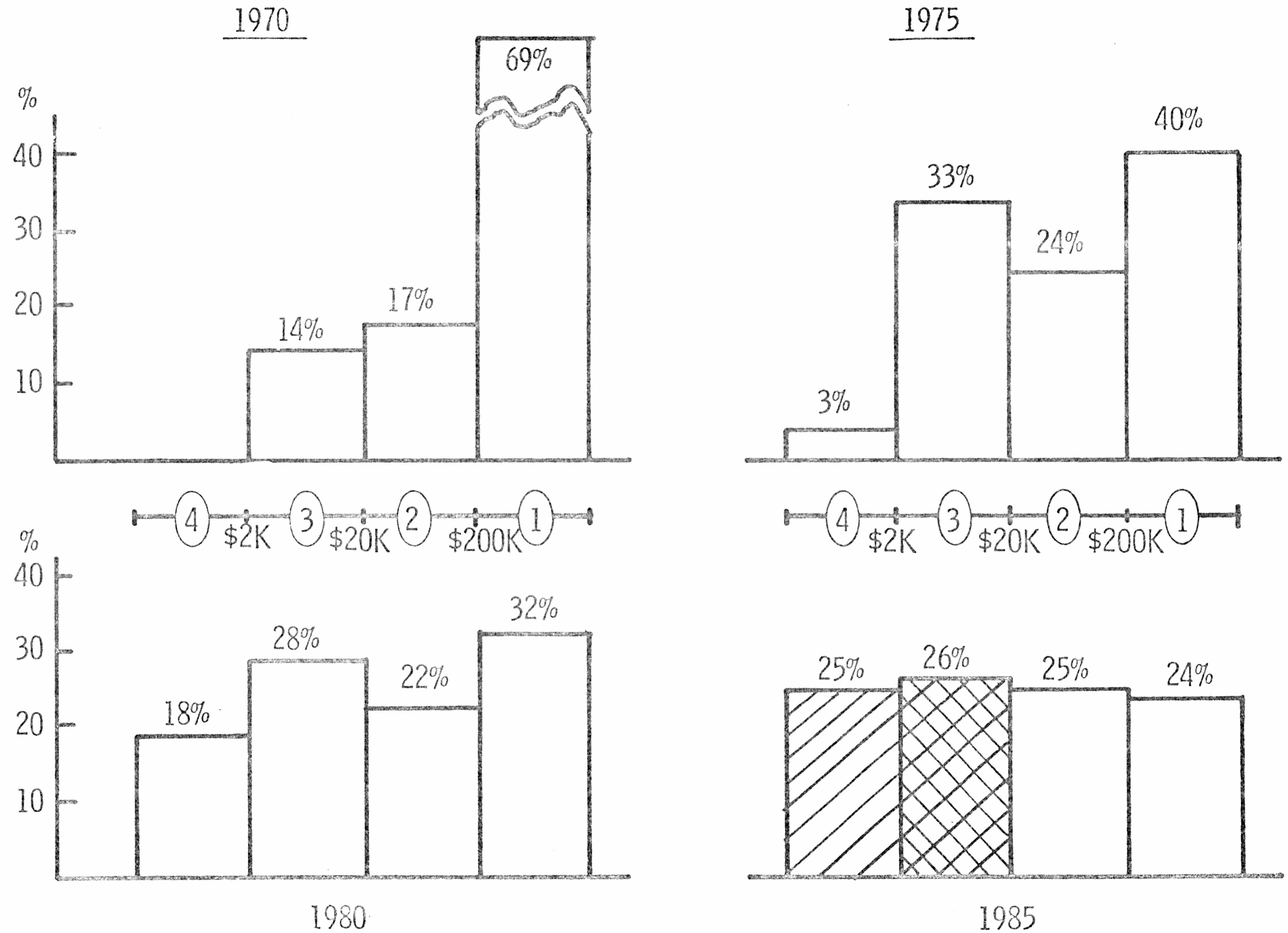
COMPUTER EQUIPMENT TRENDS
(DISTRIBUTION OF DOLLARS)



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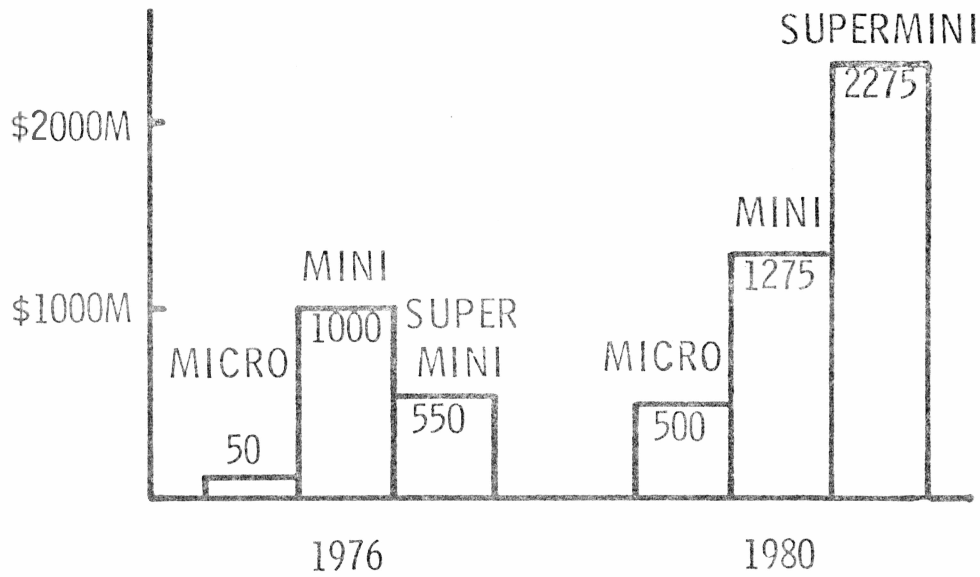
Slide 13:

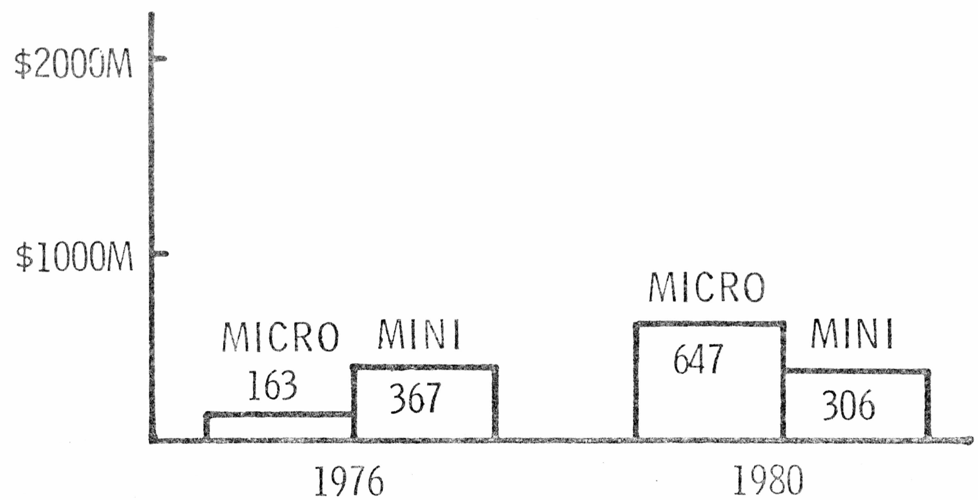
Here are some historical and projected shifts in market size between the function levels. Each segment shows market distribution across the four levels Top left, in 1970, 69% was in Level 1, large central systems costing over $200K. By 1985, the distribution is virtually flat across the levels. We don't have to move way up the scale to engage large markets. By 1985, 51% of the computer equipment market is in Levels 3 and 4: Under $20K. Why not concentrate our resources there and let the market migrate toward us?

That's fine, but we can't sit still and wait. These systems will be far more powerful by then, and peripherals will account for about 80% of the dollars.

DISTRIBUTED COMPUTING
MINI VERSUS MICRO TRENDS



- INCLUDES PERIPHERALS
- EXCLUDES MICROCOMPUTER BOARDS



- EXCLUDES PERIPHERALS
- INCLUDES MICROCOMPUTER BOARDS

Source: Gnostic Concepts; IDC

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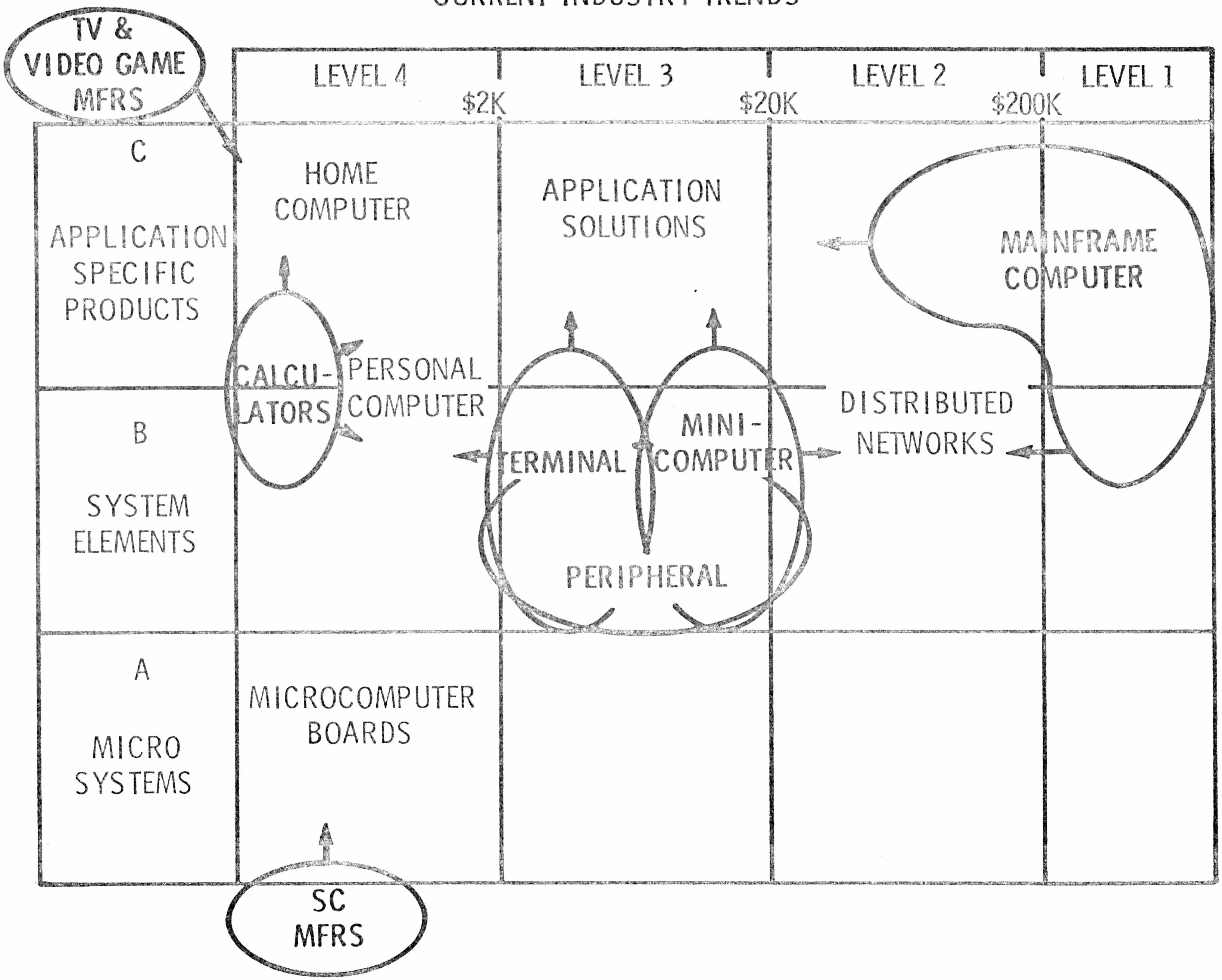
Slide 14:

That's fine, but we still have to stretch for the expanded capability that will be demanded. The supermini is growing far faster than minicomputers; the microcomputer faster than both, and the mini is squeezed in the middle. At the bottom, projections that exclude peripherals, but include microcomputer boards seem to tell a different story. Microcomputers still grow strongly, but minicomputers are actually down slightly. What's happening is that minicomputer CPU's are flat, and the growth is all in peripherals. In fact, over 90% of the minicomputer market consists of peripherals by 1980. There are two messages: push microcomputers in strategy level A, and push peripherals in Strategy level B.

History has repeated itself. The migration theory would have told us this: it happened before in the growth era for minicomputers, while peripherals were mushrooming around mainframe computers.

DISTRIBUTED COMPUTING
CURRENT INDUSTRY TRENDS



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Slide 15:

Let's summarize the industry trends. At the lower left, semiconductor manufacturers are moving up to capitalize on the microcomputer growth. Top right, mainframe manufacturers are moving down to confront the mini-makers, with distributed networks in the battleground. Peripheral manufacturers proliferate, and some are acquired by the mini-makers to protect their value-added. Minicomputers and intelligent terminals are converging, moving up to create and serve new application-oriented needs. Top left, personal and home computers evolve from calculators and move right to confront the terminal world. DSD is centered in sector B-3, but with insufficient breadth in peripherals or application solutions.

The 990 family and intelligent terminals must be brought to maturity. Only then will we have the hardware and software tools to build application solutions around. Meanwhile, competitors like IBM and DEC with mature computer families are busily stressing penetration of the Level 2 and 3 application segments. That's our dilemma, but the strategy is clear: get the tools ready, expand in peripherals, then carefully select the later emerging application segments while they are still in the growth stage.

But we have other corporate strengths not available to our competitors: our consumer base at C-4 and our semiconductor base at A-4.

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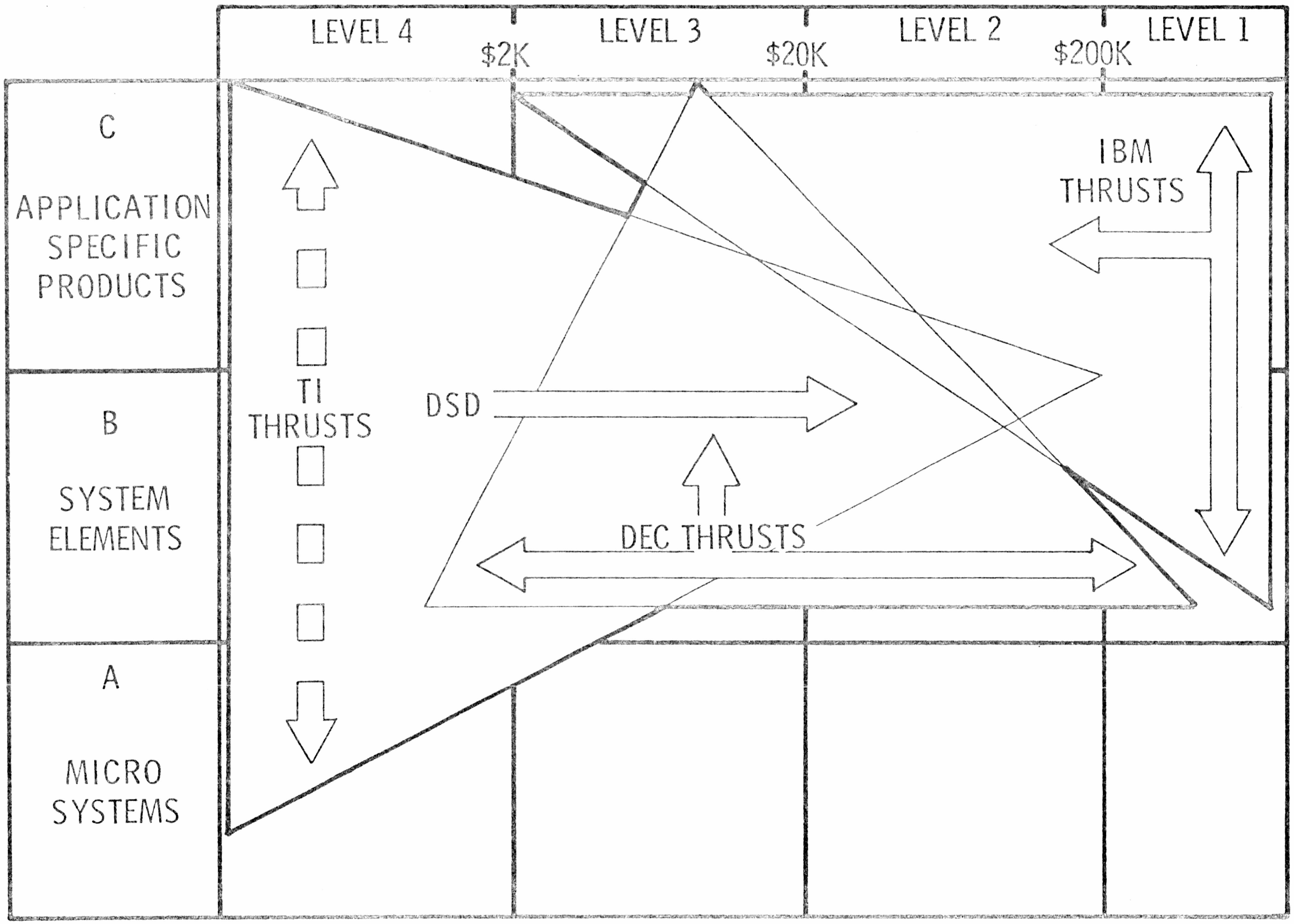
GLOBAL STRATEGY



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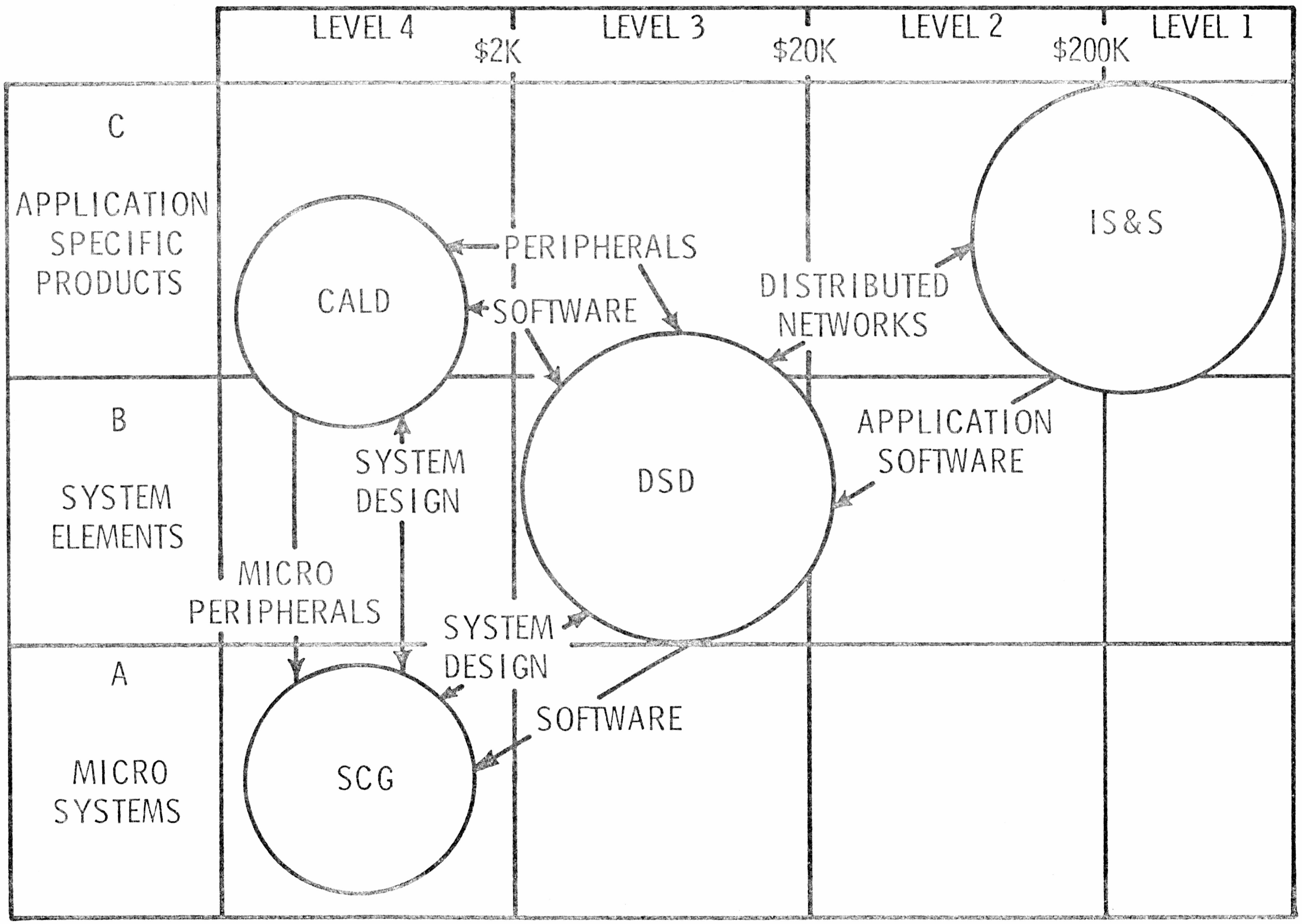
Slide 16:

This suggests a base of TI strength along the Level 4 axis, thrusting to the right. IBM's traditional base has been along the Level 1 axis, thrusting left. DEC's traditional base is horizontal at the B level, with a strong upward thrust. I believe this pattern offers us a unique opportunity. We can build our own customer base in Level 4. We can exploit consumer-like volume in modules and computing functions that are usable at higher levels. None of our competitors have the advantage of this consumer base. DSD is the spearhead of this strategy. DSD can benefit from consumer-generated volume, and because of migration, can pass on software and systems know-how to both SC and consumer businesses.

DISTRIBUTED COMPUTING
TI OPPORTUNITY FOR SHARED EXPERIENCE



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Slide 17:

This posture is illustrated here. Opportunities for shared experience exist in at least four key interfaces. Management of these interfaces is a key challenge in distributed computing at TI. The boundary between DSD and IS&S offers the basis for a selective penetration of Level 2, with large distributed networks based on TI's internal experience. At every boundary, DSD can be both a contributor and a beneficiary.

Let's look at the status and opportunities in each of the A, B, and C levels.

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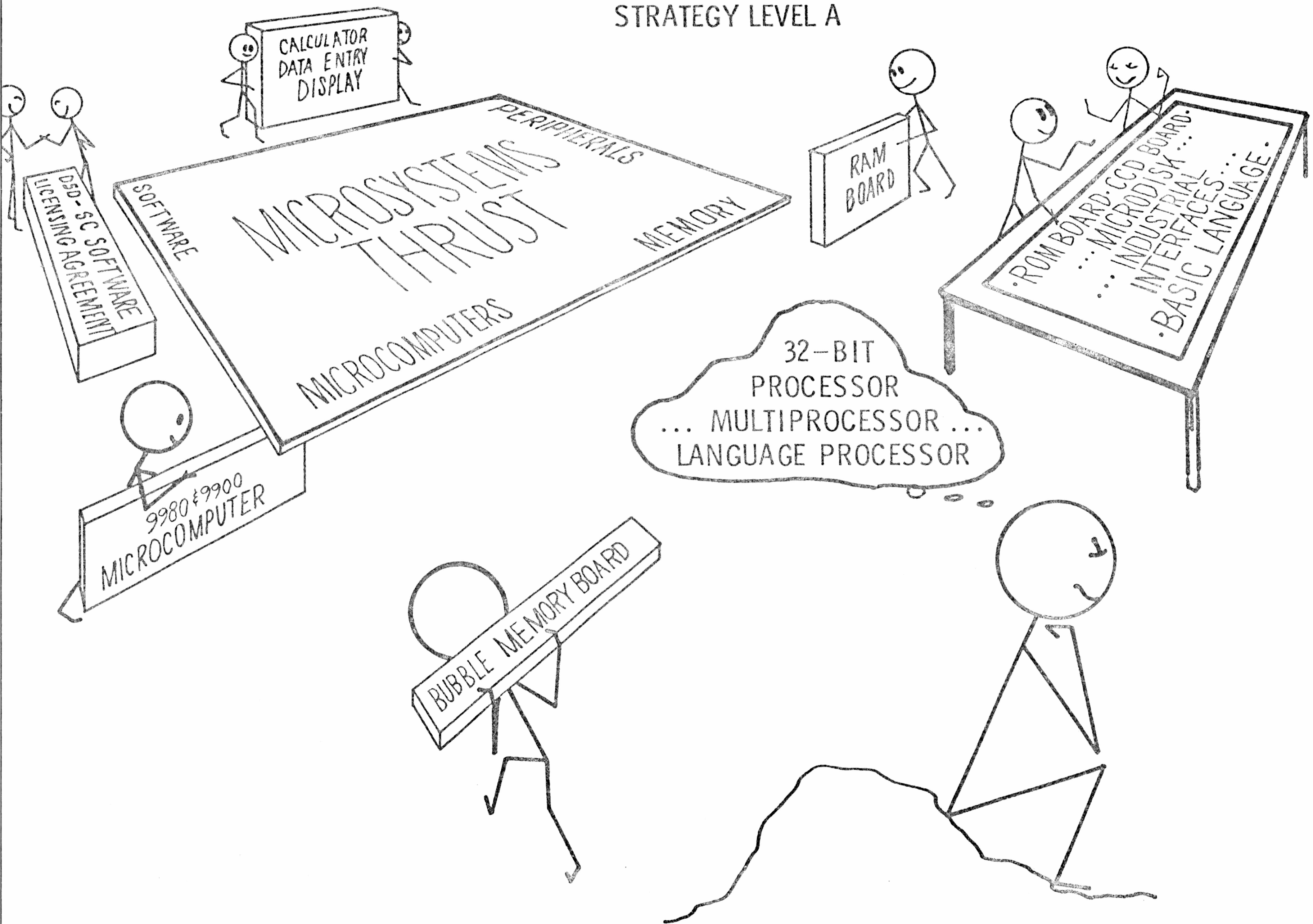
STRATEGY LEVEL A



Slide 18:

microsystems strategy, the 9980 and 9900 microcomputer boards will soon be available along with a calculator-based data entry and display unit. CRL is designing a bubble memory board. Software available from DSD will help support the thrust. Several products are on the drawing board and will be completed during the next year. Further issues like a 32-bit processor, multiprocessors, and language processors were discussed yesterday by Harvey Cragon.

DISTRIBUTED COMPUTING
STRATEGY LEVEL A

CAPA-BILITY LEVEL	1977	1980	1983	1986–1989
990/XX			SUPER MINICOMPUTER	MINICOMPUTER
990/15		SUPER MINICOMPUTER	MINICOMPUTER	MICROCOMPUTER BOARD
990/12	SUPER MINICOMPUTER	MINICOMPUTER	MICROCOMPUTER BOARD	CHIP
990/10	MINICOMPUTER	MICROCOMPUTER BOARD	CHIP	
990/4 990/2	MICROCOMPUTER BOARD	CHIP		
9900	CHIP			

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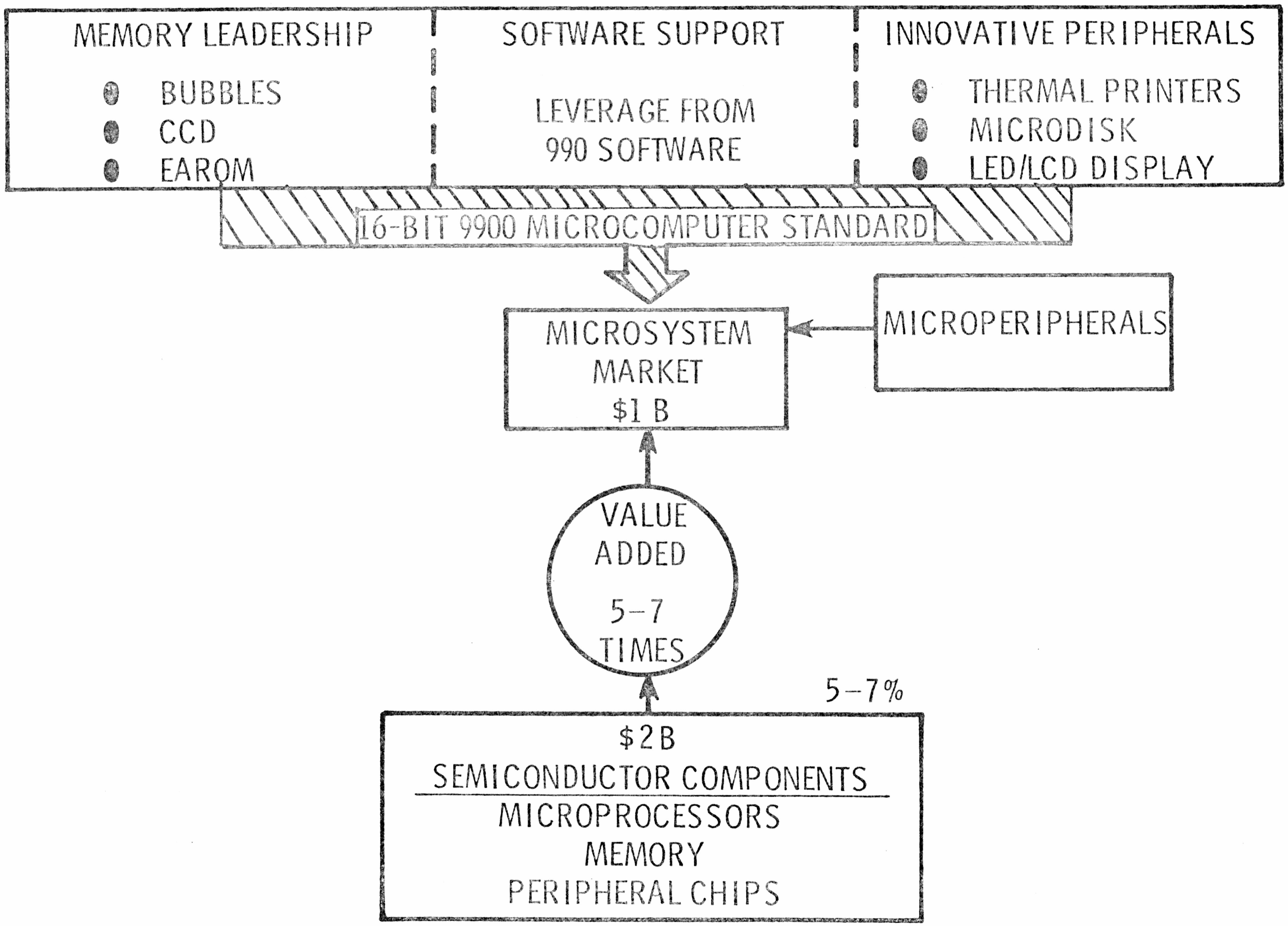
Slide 19:

The dynamics of increasing integration levels are illustrated here. The horizontal dimension shows the capability of a 990/12 embodied in a single board microcomputer, then on a single chip by the late 1980's. Columns show the range of capabilities at any given time. Diagonals illustrate the advance of functional power with time. Any cell on the chart can look upward and see an image of what he must become in the next time period. The chip looks up to the microcomputer board for guidance on its next generation.

Another key dynamic is the sharing of software across generations, as operating systems are passed on from mini to micro to chip. We have not yet seen the reinforcing effect of this, because we have essentially entered the chart on the left edge at three levels simultaneously. Moving beyond these start-up conditions and into steady-state, we can expect increasing leverage from our OST investments. This leverage increase is a key factor in DSD's future performance, as Joe Watson and John Hanne will describe later.

This chart makes clear why, in a DSD priority choice between the 990/12 and 990/2 for the next product introduction -- the 990/12 was absolutely the right way to go. The 990/12 has a long future ahead, while the 990/2 is shortly destined to be a chip. The 990/2 charter has since been moved to SC Group.

DISTRIBUTED COMPUTING STRATEGY LEVEL A



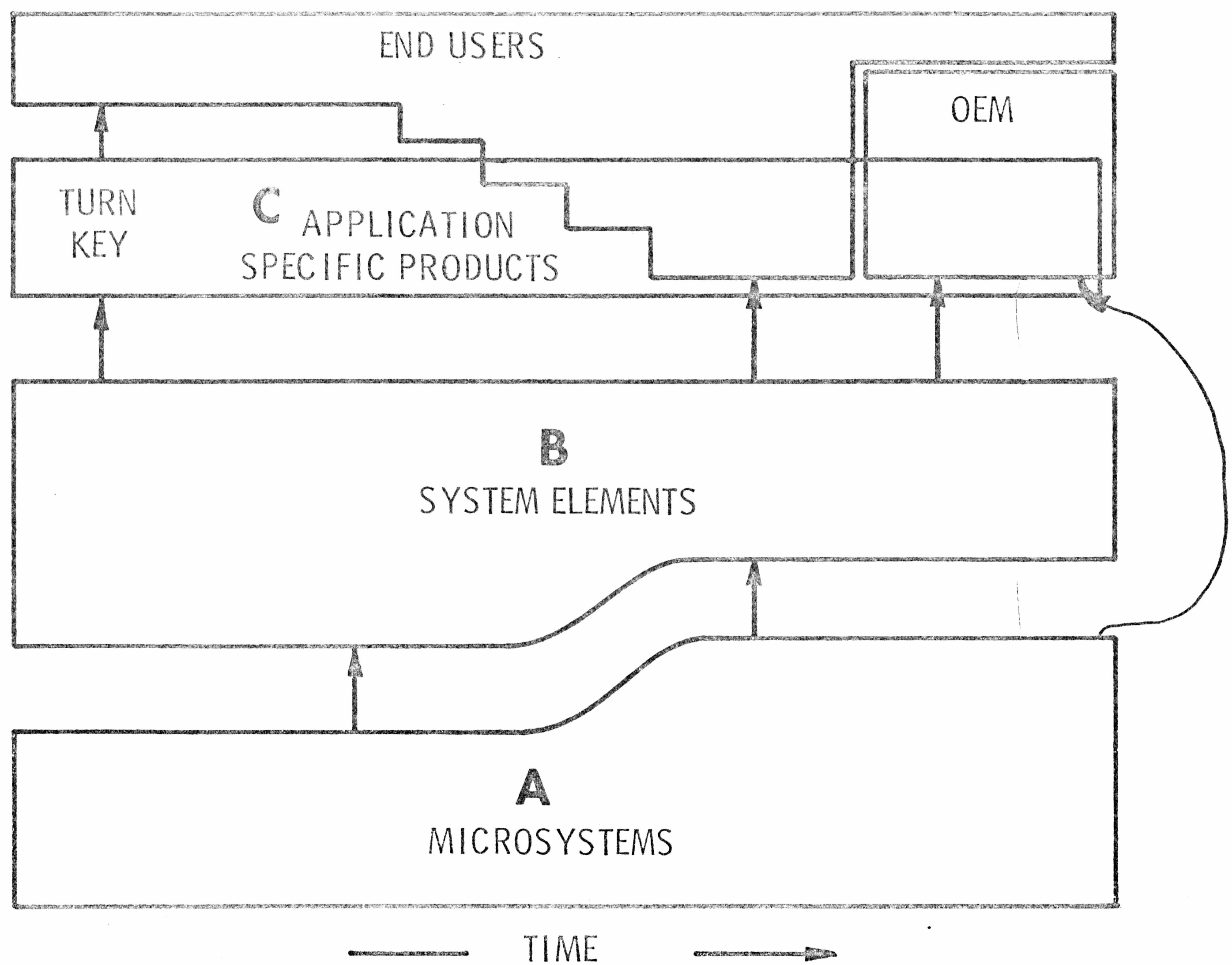
1980 MARKETS

Slide 20:

Our challenge is to make the 9900 series become the 16-bit microcomputer standard. We have memory leadership products and we have the leverage from the 990 minicomputer software, and opportunities in our potential for low-cost peripherals. The lower part of the figure shows 5-7% of the chip flowing to

microsystems. However, each dollar of SC content is multiplied by 5-7 before reaching the system selling price. The resulting microsystem market is $1B by 1980, half the size of the component market. What's behind this projected growth?

DISTRIBUTED COMPUTING
STRATEGY LEVELS



Slide: 21

Looking back at the ABC levels, OEM's are increasingly going direct to the SC industry as a tactic to cut a level out of their procurement chain. SC firms are responding through integration and board-level assembly. Earlier this year, we established a microsystems thrust in Jim Van Tassel's microprocessor strategy, with Kurt Boehnke moving from DSD to SC. In the past, TI has tended to avoid the board assembly business -- so what's the difference this time? What's different is the flexibility of the microprocessor itself: Now, we aren't designing custom assemblies for special applications. We are providing a family of standard modules, bringing computer power to a whole new range of applications. Through commonality and standardization, we can reach applications which could never afford their own individual module designs. What was a custom business is now one of commonality -- and a C-level business of specialization is being transformed into an A-level strategy based on commonality.

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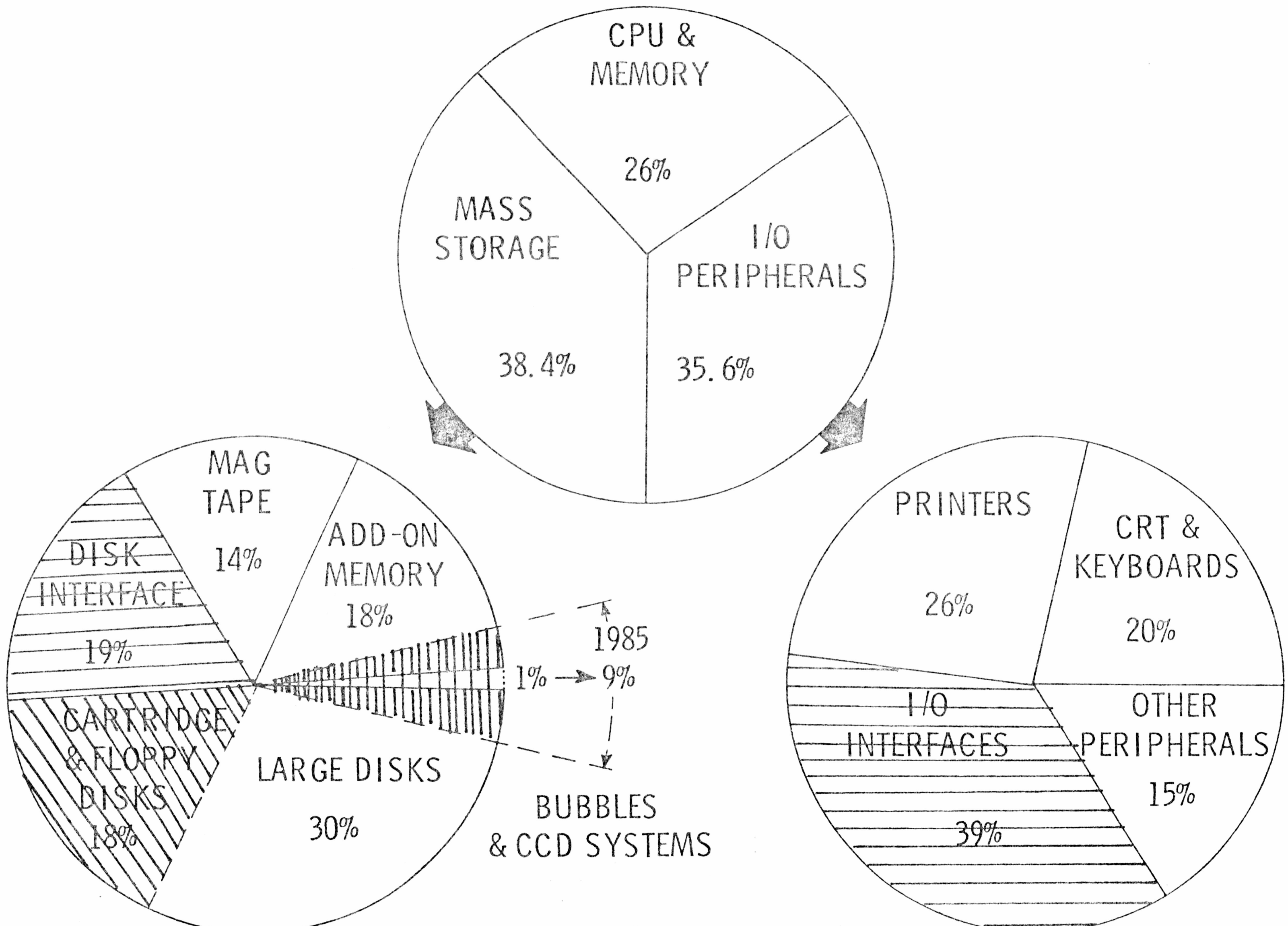
STRATEGY LEVEL B
COMPUTER PERIPHERALS MIX: 1980



Source: Gnostic Concepts

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Slide 22:

By 1980, the CPU and memory portion of all computer equipment will be only 26%. For minicomputers, it's even less.

Therefore, the two sectors, mass storage and I/O peripherals, are going to be crucial to our success. In mass storage, we have a unique opportunity in the bubble and CCD memory systems, projected to reach 9% of mass storage by 1985 and that's almost a billion-dollar opportunity where we have a leading position. Another is the floppy disk where the ADD disk can have major impact.

Another opportunity is peripheral interfaces, comprising 21% of the total, where SC integration could have a greater impact and migrate more of these functions to the A level.

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STRATEGY LEVEL B
PERIPHERAL OPPORTUNITY

INPUT AND OUTPUT

- THERMAL LINE PRINTER
- THERMAL GRAPHICS PRINTER
- DOCUMENT SCANNER
- OCR INPUT
- INK JET PRINTING
- VOICE INPUT
- LED/LCD DISPLAY

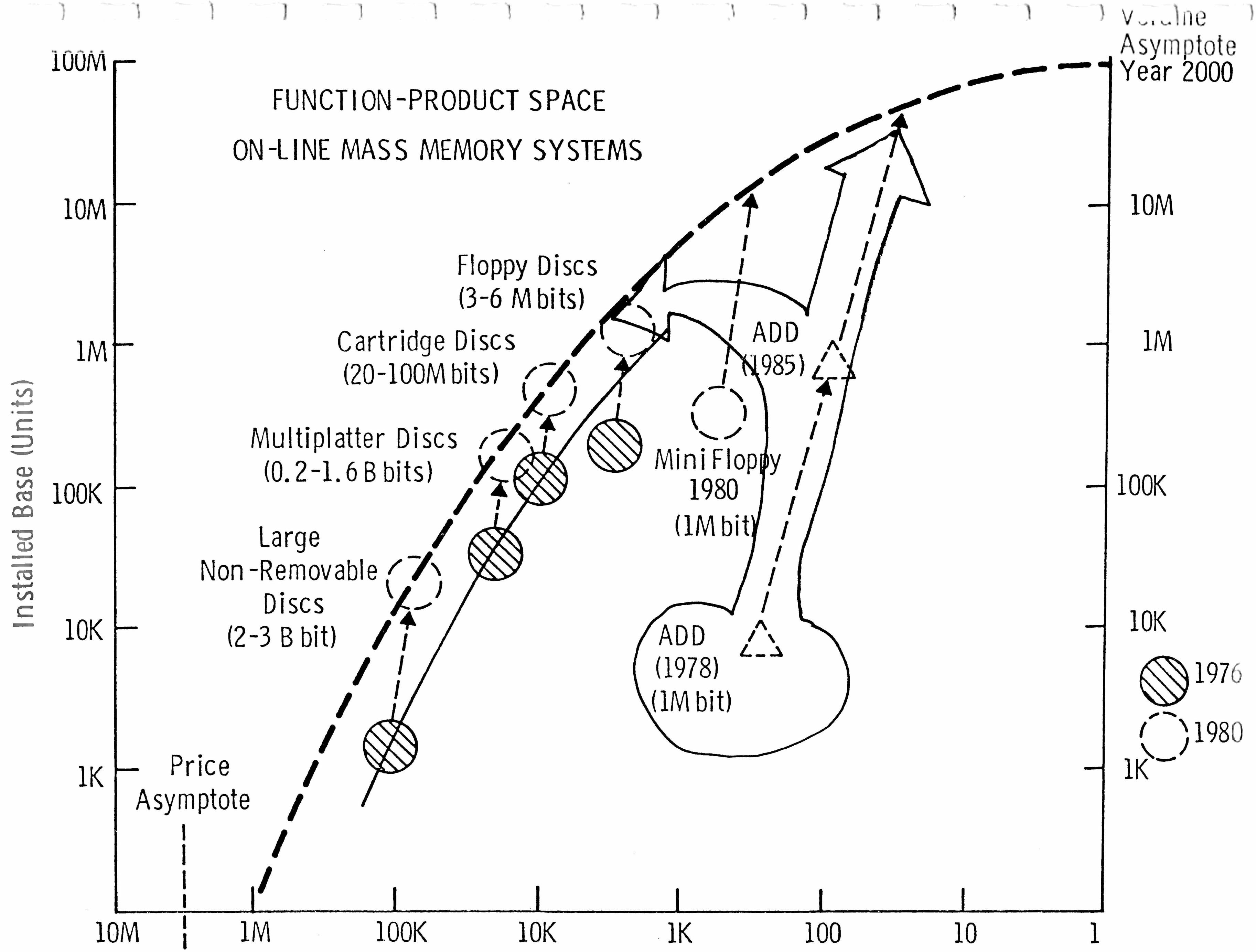
MASS STORAGE

- MAGNETIC BUBBLES
- CCD
- ADD

Slide 23:

In the input/output sector we have opportunities in all the areas listed. Active programs exist in each of these areas, though in some cases at very low exploratory levels.

In the mass storage segment, the Advanced Disk Drive, or ADD, is an example of scaling a peripheral product to the Level 4 customer base. ADD is under development in the Corporate Engineering Center, but located at Austin to enhance interaction with DSD. It's the first out-of-Dallas CEC project.



Non-TI Data Source:
Gnostic Concepts

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Slide 29

It's illustrated here in the function product space for mass storage. This shows existing and potential installed base for a wide variety of mass memory products. The ADD product initially targets a gap in this space, at a price/volume point characteristic of consumer-type products. But the technology used affords growth potential in performance to work down the curve, displacing existing memory products.

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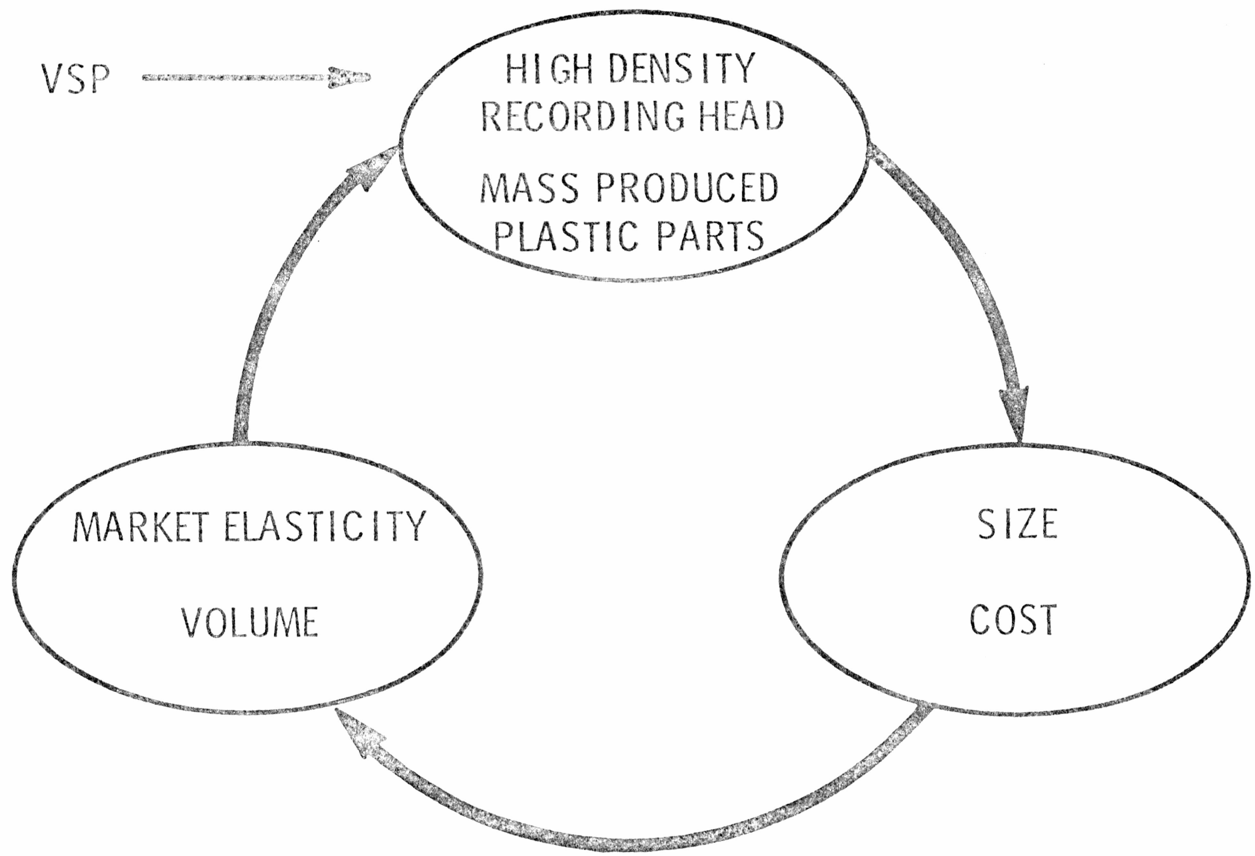
ADVANCED DISK DRIVE (ADD)



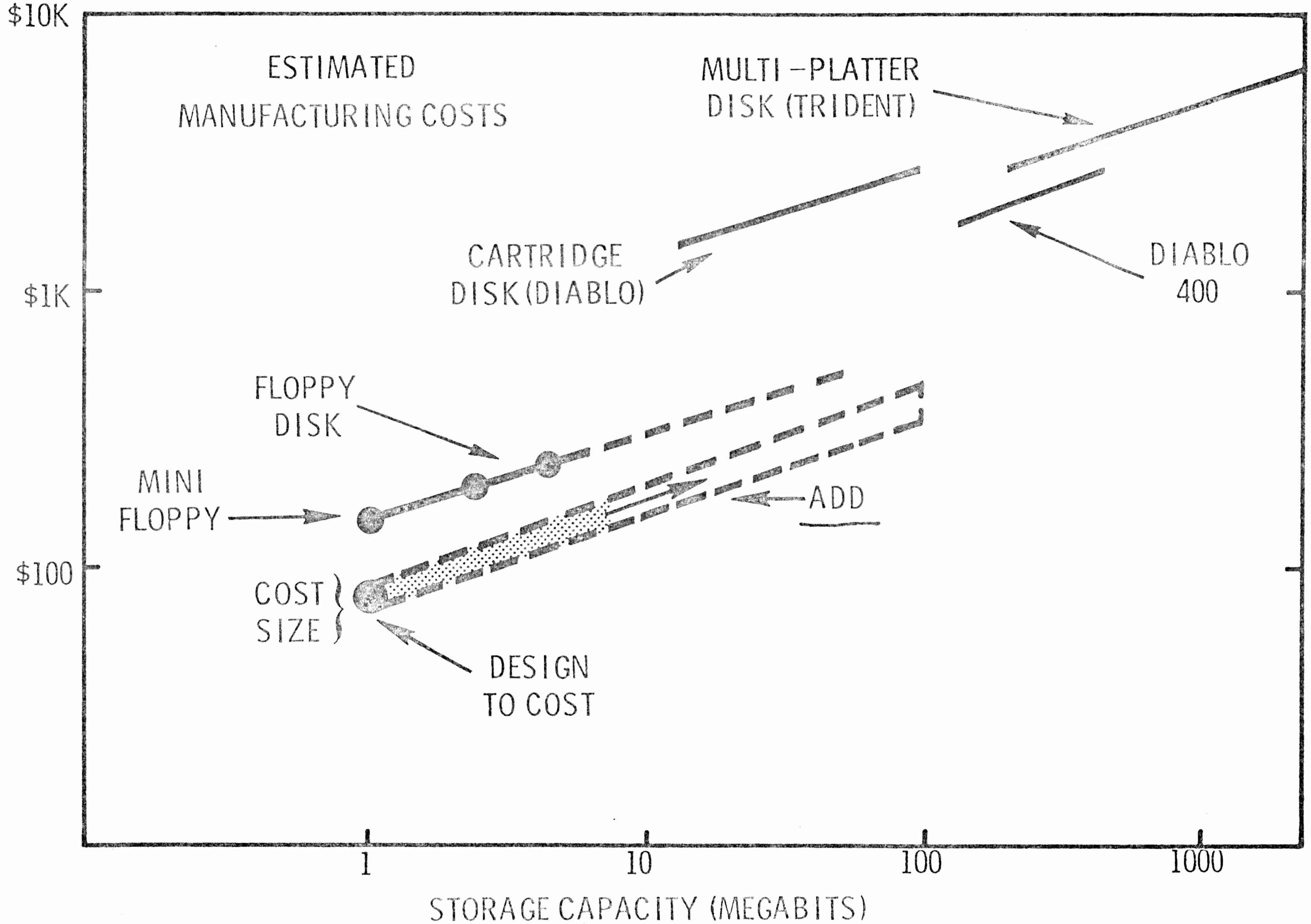
STRATEGY

- EXPLOIT VSP TECHNOLOGY
- REACH MICRODISK WINDOW FIRST
- PREEMPT VOLUME FOR BUILT–IN DISKS
- DISPLACE EXISTING FLOPPY TECHNOLOGY

Slide 25:

ADD takes advantage of high density recording head technology developed on another consumer program, VSP. This, together with an overall design predicated on high volume plastic parts, provides both size and cost advantages. Both will contribute to market elasticity, but especially the size, which makes possible for the first time a built-in disk for terminal and calculator-sized products. We must reach the microdisk time window first, preempt the volume for built -in disks, and then consider using this volume as a base to displace larger scale floppy and cartridge disk technology.

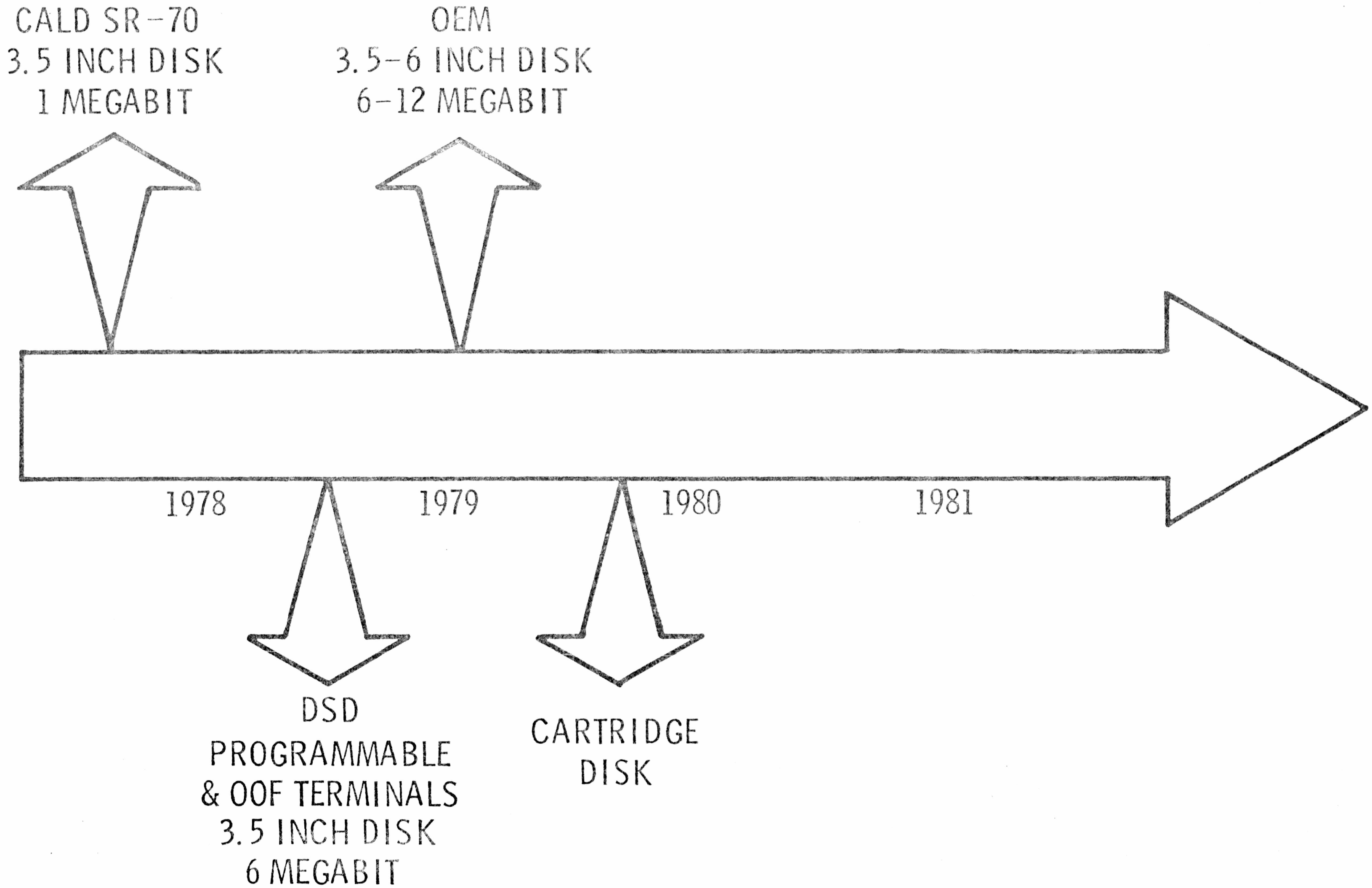
DISTRIBUTED COMPUTING
ADD DISK DRIVE VERSUS COMPETITION



Slide 26:

The design to cost program for ADD puts us well below estimated costs for competitive products. The high density recording technology will allow us to move up under the floppy disk costs, with continuing size advantages. The potential exists in subsequent product generations to invade the cartridge disk domain.

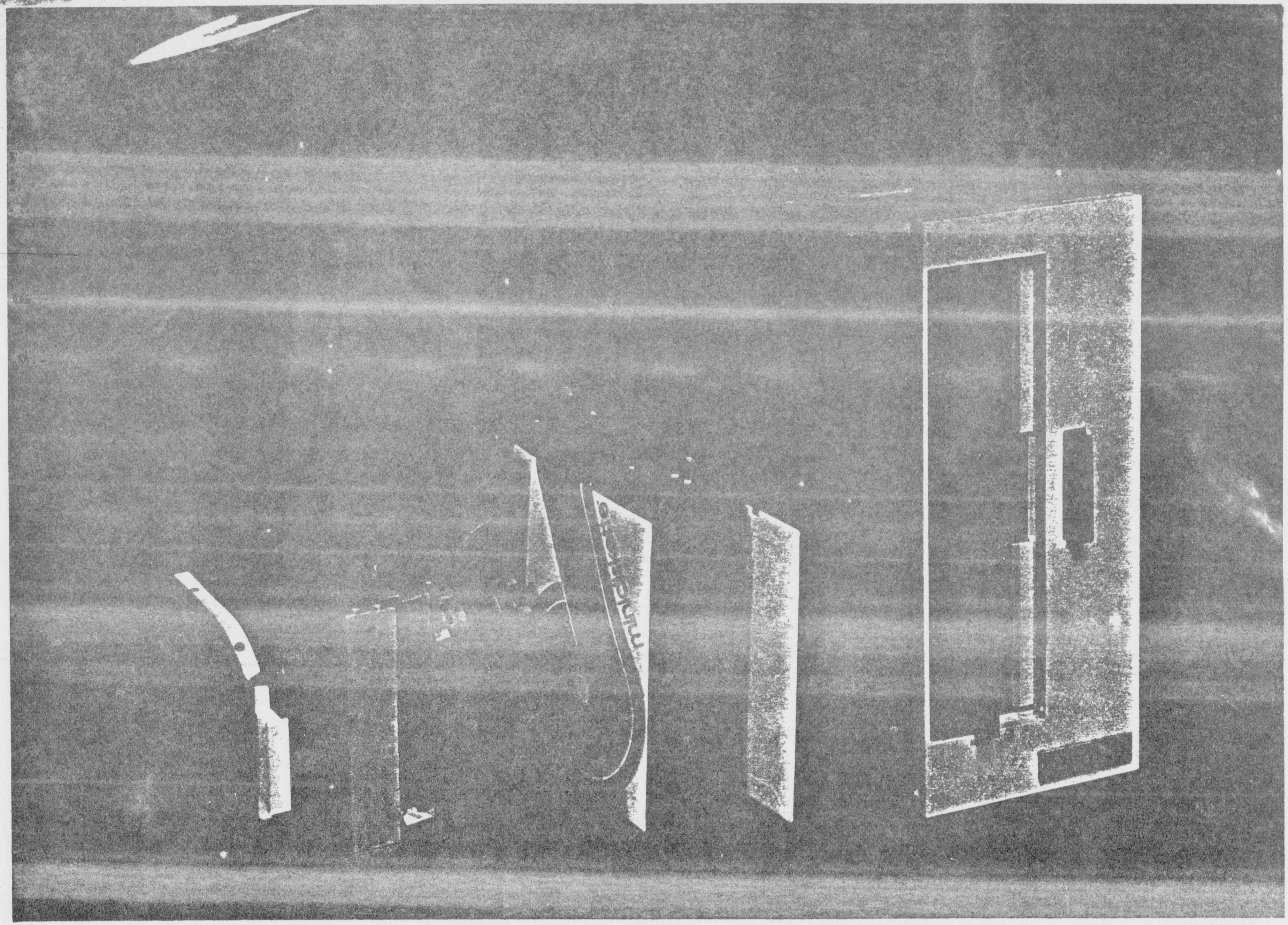
DISTRIBUTED COMPUTING
ADD PRODUCT POTENTIAL



Slide 27:

The product development plan begins with the CALD SR-70 personal computer, which is largely based on the ADD disk capability, and you'll hear about it tomorrow. Next, ADD can provide a leadership advantage in DSD intelligent terminals, and Jim Eckhart will discuss this later today.

30



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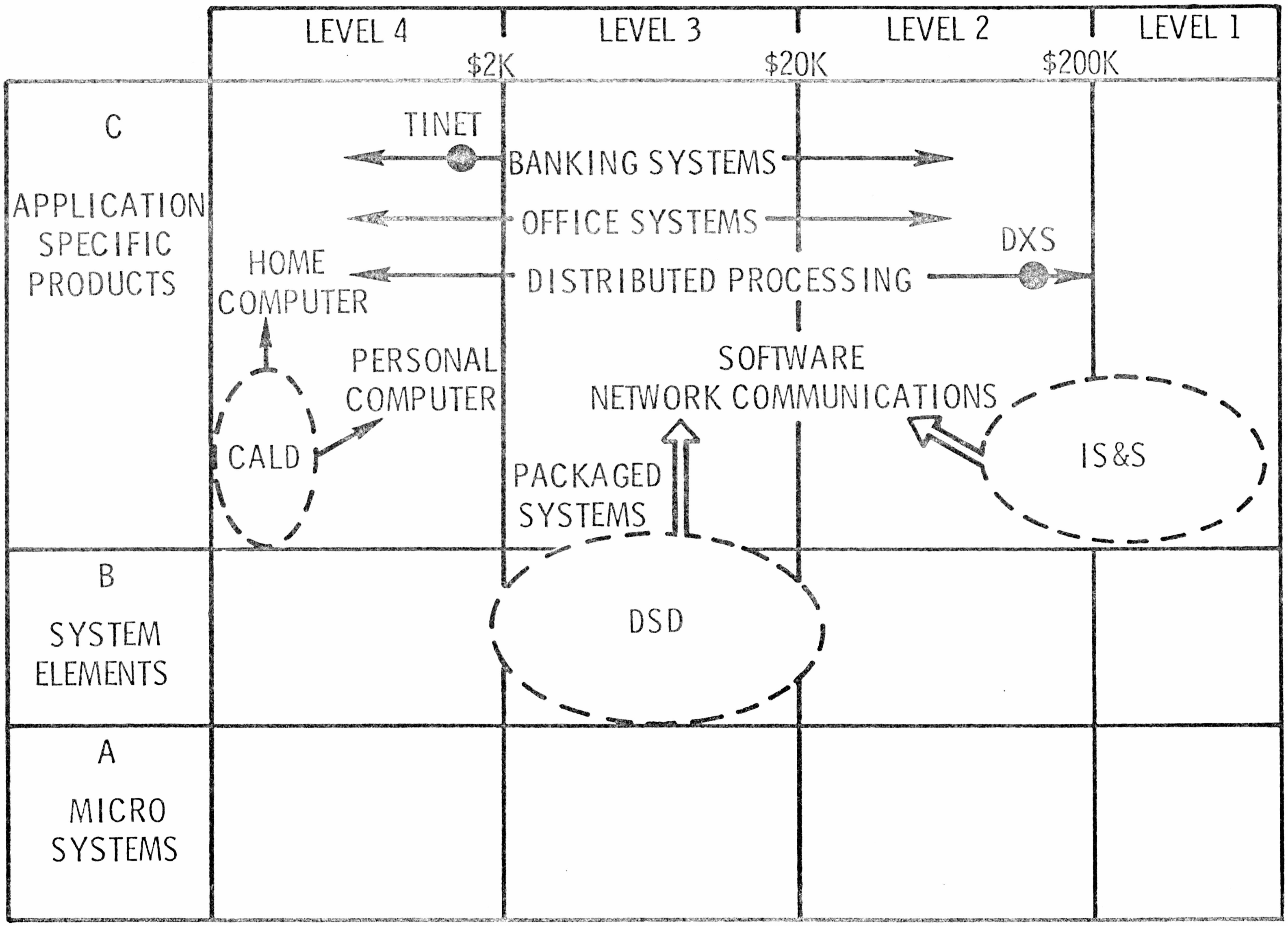
Slide 28:

The photograph shows on the left an early engineering model, with one version of a disk loading cartridge. In the center is the Shugart mini floppy of equivalent capacity, recently announced, and on the right, a conventional floppy of three megabit capacity. The ADD technology will allow us to reach this capacity in the size of the left-hand unit.

DISTRIBUTED COMPUTING
STRATEGY LEVEL C
APPLICATION SPECIFIC PRODUCTS



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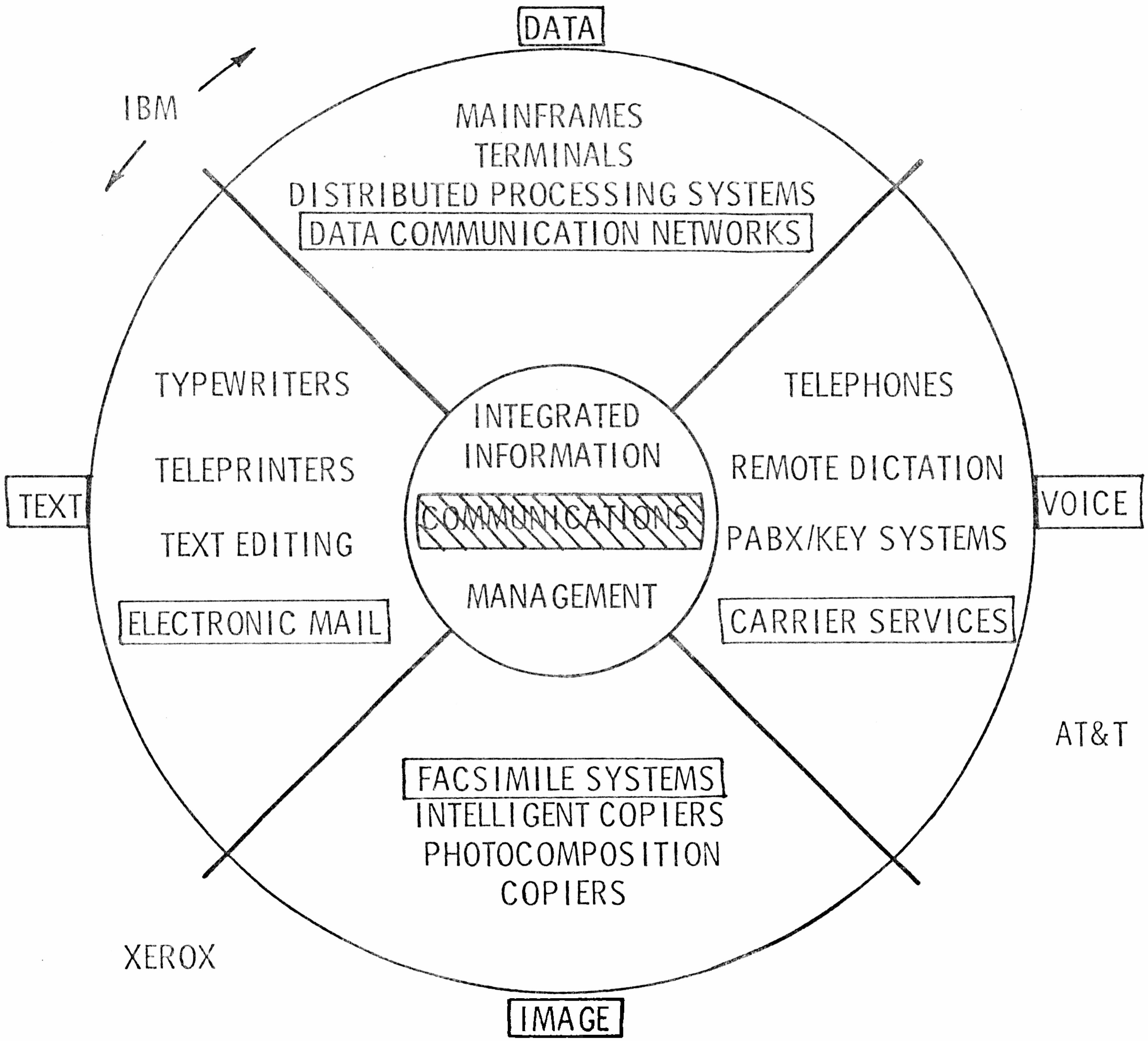
Slide 29:

Now, in the applications specific products at Level C, CALD must move strongly to applications with the personal and home computers. Software support from IS&S and a new research program on user oriented languages in CRL are now closely coupled with CALD.

Next, we must focus the resources of both DSD and IS&S on the software and network communications problem with which we could penetrate the application specific domain at Levels 2 and 3. The innovation required is the concurrent solution of both our internal and the external distributed processing needs. It will cost somewhat more to include external requirements from the start, but the leverage potential is great. We must walk a narrow line though: being certain to get our tools together at Level B first, but shifting some resources to application thrusts as early as possible.

DISTRIBUTED COMPUTING
COMMUNICATIONS AT THE CORE

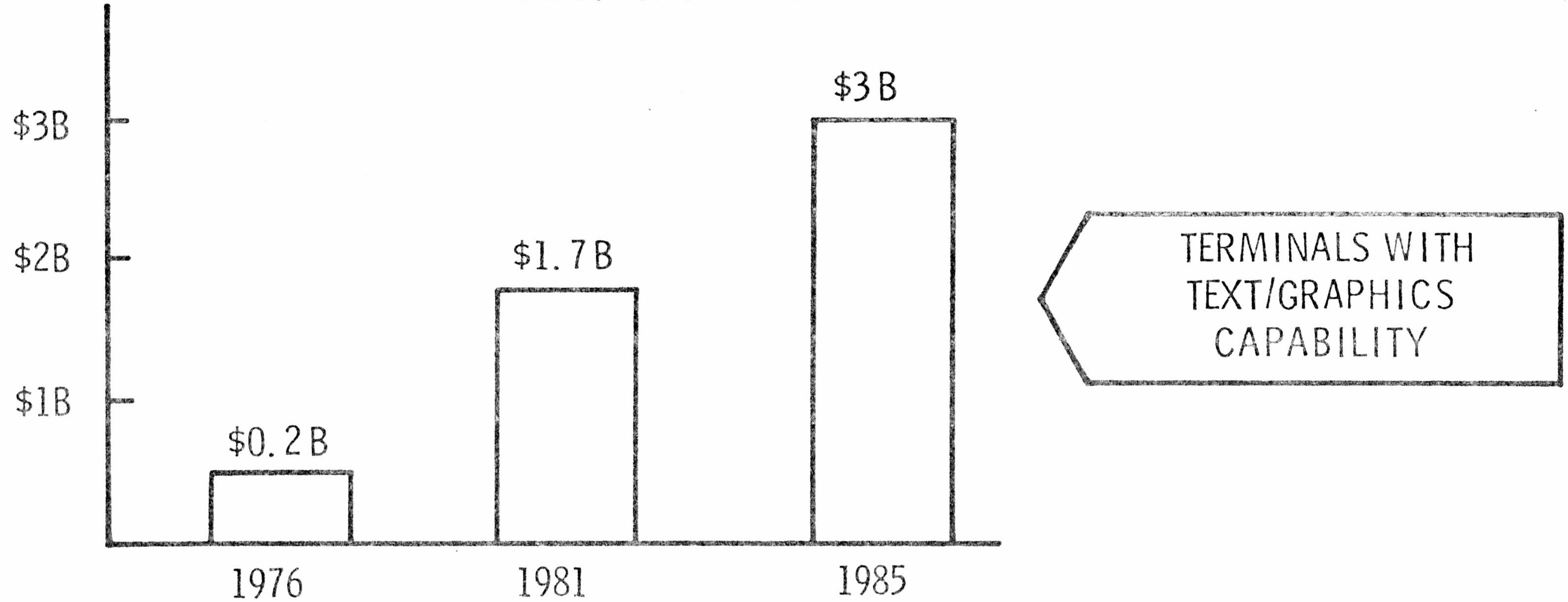


Slide : 30 :

However the world of distributed computing is approached, communications is the common bond, the coordinating link. It can be approached strategically by a number of industries -- data, voice, image, and text processing, for example. They all converge upon communications.

Each industry has its own strengths and weaknesses, but here's one task which seems especially well suited to TI. It's electronic mail. Take the text editing office products plus communications, and you have a start toward electronic mail.

DISTRIBUTED COMPUTING
ELECTRONIC MAIL OPPORTUNITY



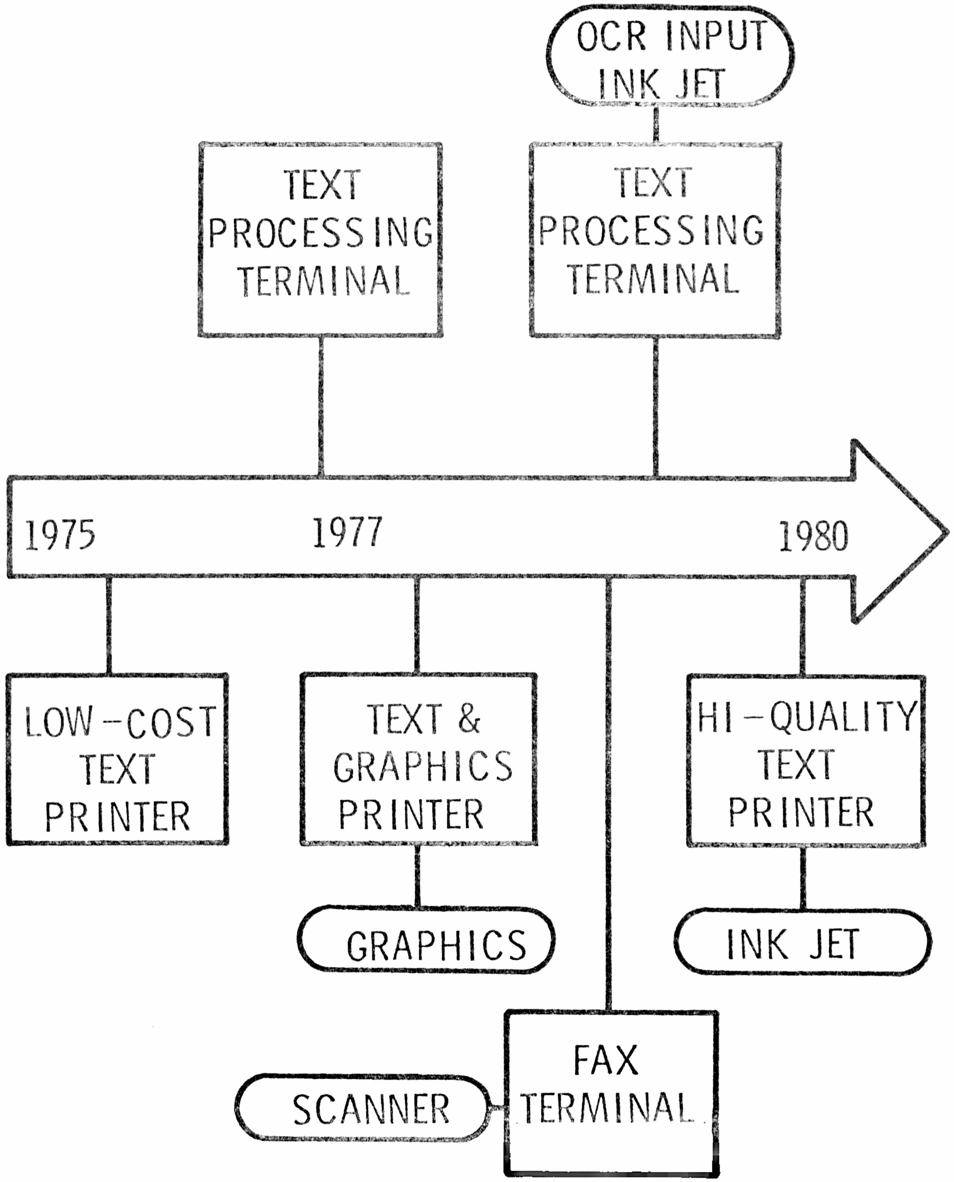
DRIVING FORCES:

- TEXT PROCESSING GENERATES DIGITIZED TEXT
- HIGH VOLUME OF INTRACOMPANY MAIL
- COST AND DELAY OF POSTAL SERVICE
- PACKET COMMUNICATION OFFERS LOW-COST TEXT/GRAPHICS TRANSMISSION

Slide 31:

But you still need a combined text and graphics printing capability. In the field of electronic transfer systems, the banking and point-of-sale segments are already well advanced. Electronic mail is just beginning and the market for electronic mail terminals is projected to reach $3 billion by 1985. Whether stand-alone terminals or integrated into multifunction office systems, the function must be done and the opportunity is there.

DISTRIBUTED COMPUTING
ELECTRONIC MAIL PRODUCT OPPORTUNITIES



DRIVING FORCES

- EXTENSION OF TERMINALS
- EXTENSION OF TEXT PROCESSING
- HARDWARE DRIVEN OPPORTUNITY
- TECHNOLOGY BASE
  - THERMAL PRINTING
  - INK JET PRINTING
  - CCD IMAGING FOR OCR AND SCANNER
  - BUBBLES AND ADD FOR TEXT BUFFERING

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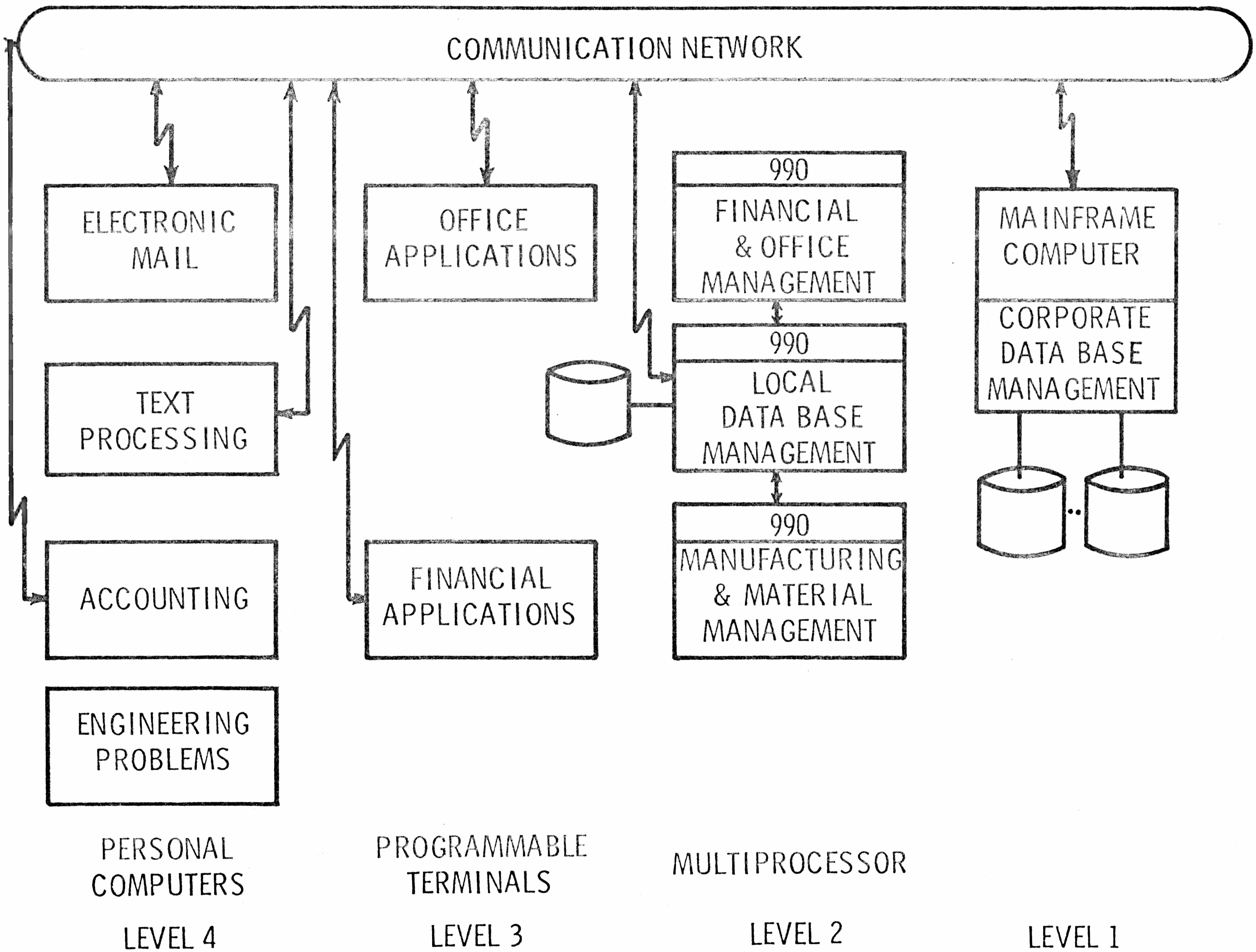
Slide 32:

The electronic mail terminal is a hardware-driven product. It's a natural extension of our terminal business and of our office systems strategy. It's a good match to our technology in bubbles, the ADD disk, CCD imagers, and thermal printing. It needs one innovation -- a truly low-cost, high-quality printer for text and graphics. The ink jet concept being explored in CRL could be it, and we must give it every chance.

DISTRIBUTED COMPUTING
NETWORK SYSTEM IN THE 1980'S



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Slide 33:

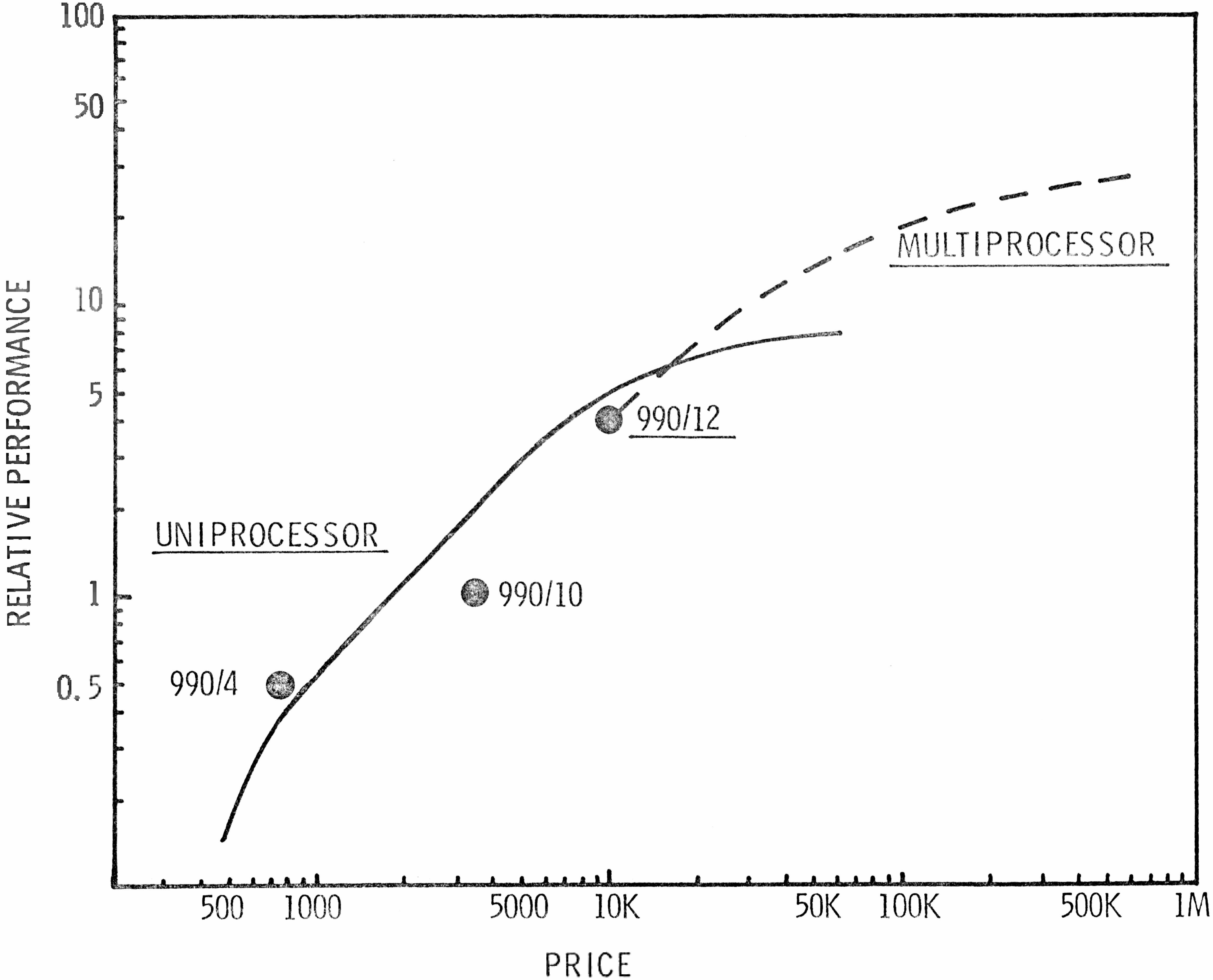
In the 1980's, we expect communication networks to be linking functions at all levels: mail terminals and text processors at the left, to corporate data bases at the right.

This chart also illustrates how TI's compatible family of products can be worked for advantage in end-user systems.

By marketing application solutions at Level 4, like accounting, text processing, etc., we can build our unique customer base. As customers grow in size and propensity to use computer systems, they can be moved up toward Level 3. The inevitable downward migration of functions will enhance this strategy. This is the classic way of developing a solid and loyal customer base. With TI's potential strength at Level 4, this can be a powerful approach. No other competitor in distributed computing has both the consumer and SC business around which to build a Level 4 customer base.

Now, moving to the right, at Level 2, multiprocessor 990 systems will offer expanded power required for the 1980's.

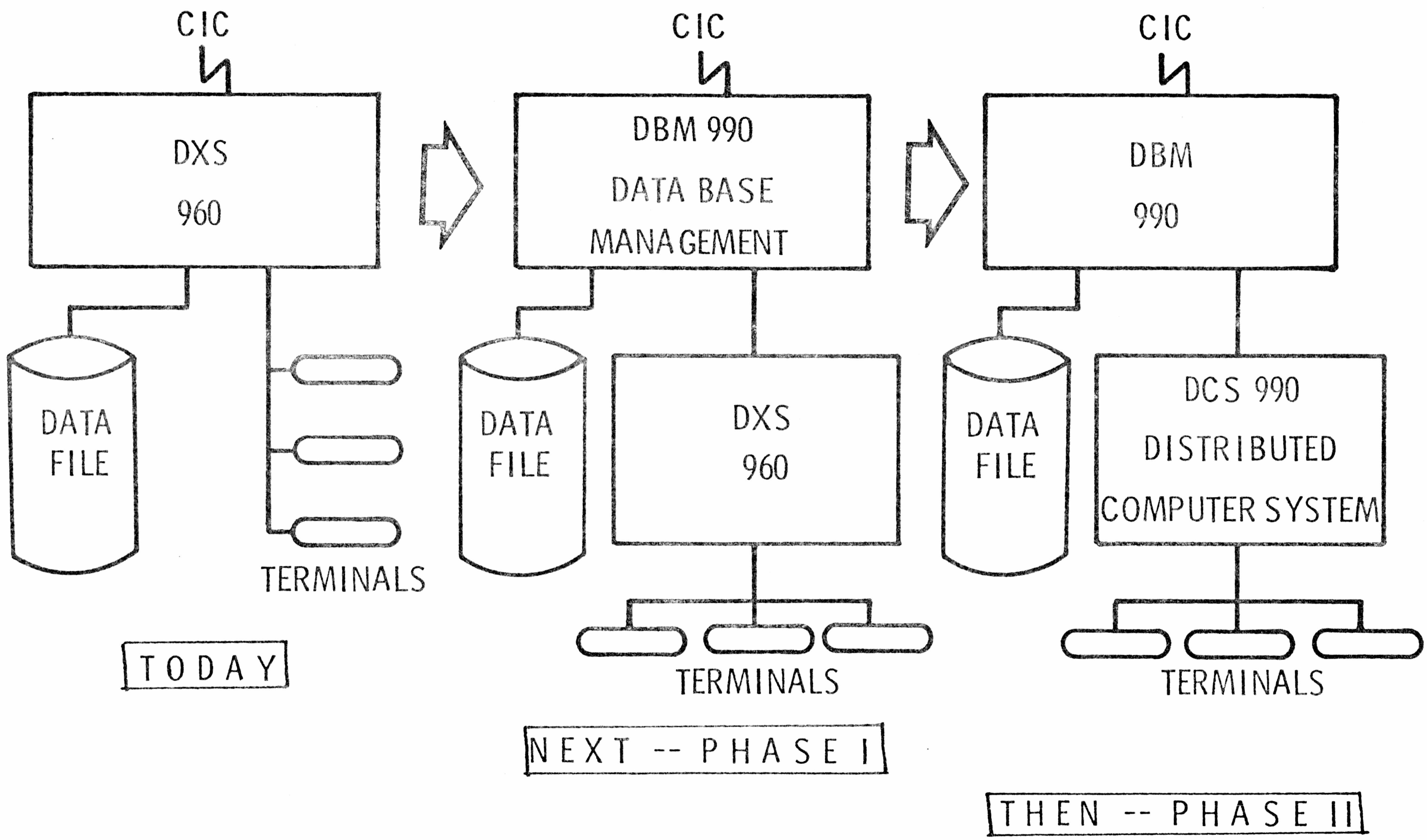
DISTRIBUTED COMPUTING
TYPICAL PRICE / PERFORMANCE RELATIONSHIPS



Slide 34

Before then, the 990 family will have reached the cost-effective limit of 16-bit architectures, with the 990/12. Achieving the indicated performance extensions requires R&D in multiprocessor technology. A number of successful multiprocessor projects, including some at TI, have been applied to specific structured applications (DABS). A number of non-successes (not TI) have also been experienced in general purpose multiprocessor programs. TI's DXS-960 comes as close as anyone yet has to a minicomputer-based general business multiprocessor. This is still a leadership opportunity for the 990 family, and a small exploratory program in the Corporate Engineering Center is now developing multiprocessor technology around the 990/12.

DISTRIBUTED COMPUTING
DXS MIGRATION TO 990



NEXT -- PHASE I

- INCREASED I/O THROUGHPUT
- INCREASED PROCESSING CAPACITY
- PROTECTS EXISTING DXS 960 SOFTWARE

THEN -- PHASE II

- EXPANDED PROCESSING CAPACITY
- DXS FUNCTION CONVERTED TO 990

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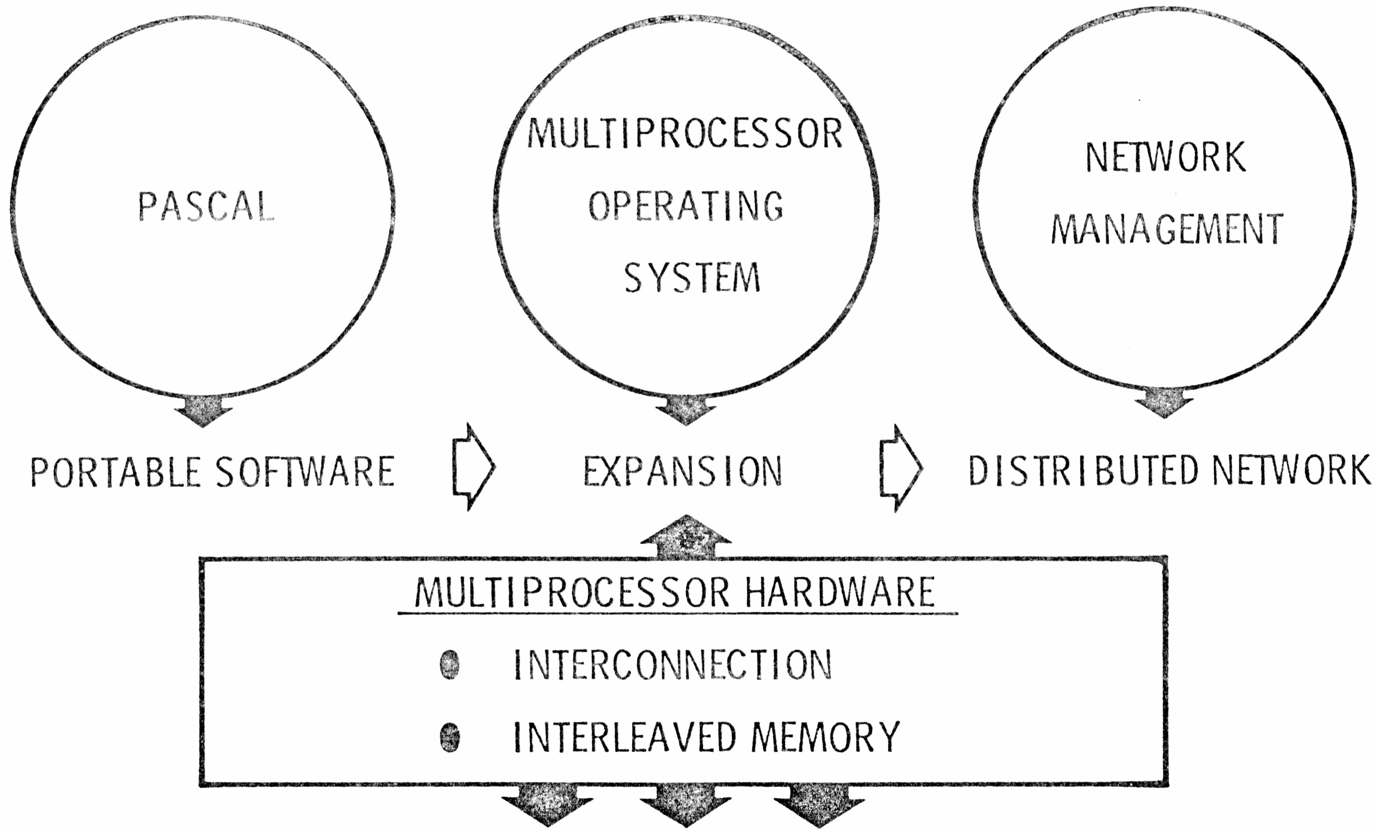
Slide 35:

To protect our existing application software, we are planning a systematic migration to the 990 from existing systems. In the first phase, data files from DXS 960 and other specialized systems are moved off and consolidated on a 990 data base management system. DXS performance is enhanced, and it can be retained for the effective life of the existing software. In Phase II, the 990 distributed computer system, likely a multiprocessor, replaces DXS and other special systems.

DISTRIBUTED COMPUTING

DESIGN BASED ON 990/12 SERVES NEAR TERM NEEDS



IMPACT ON

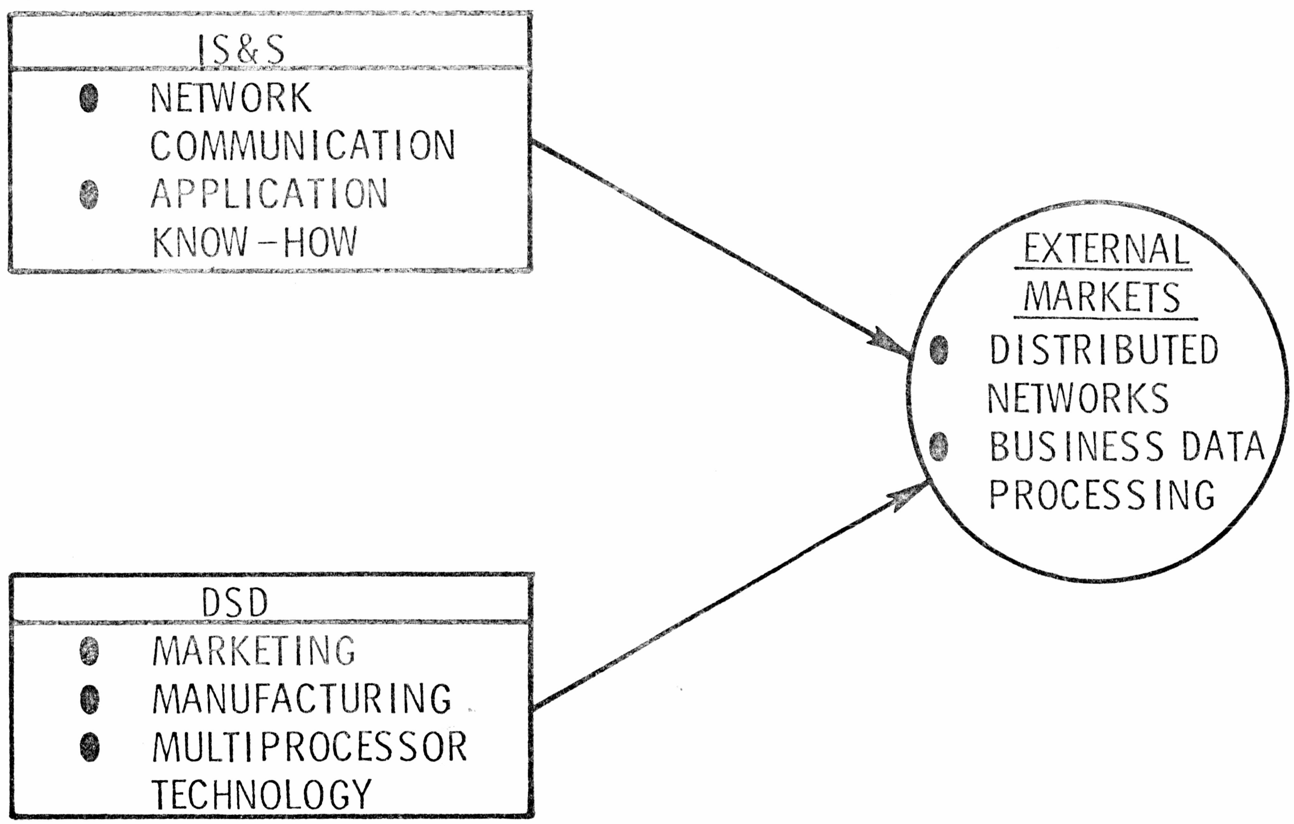
ENHANCED SYSTEM FEATURES

FOR 990/15

Slide 34:

Widespread use of the programming language PASCAL will make our new software portable to the 990/ (Roger Bate). Then, with a multiprocessor 990/12 system, coupled to the TI distributed network, we can move smoothly and efficiently to a powerful Level 2 function.

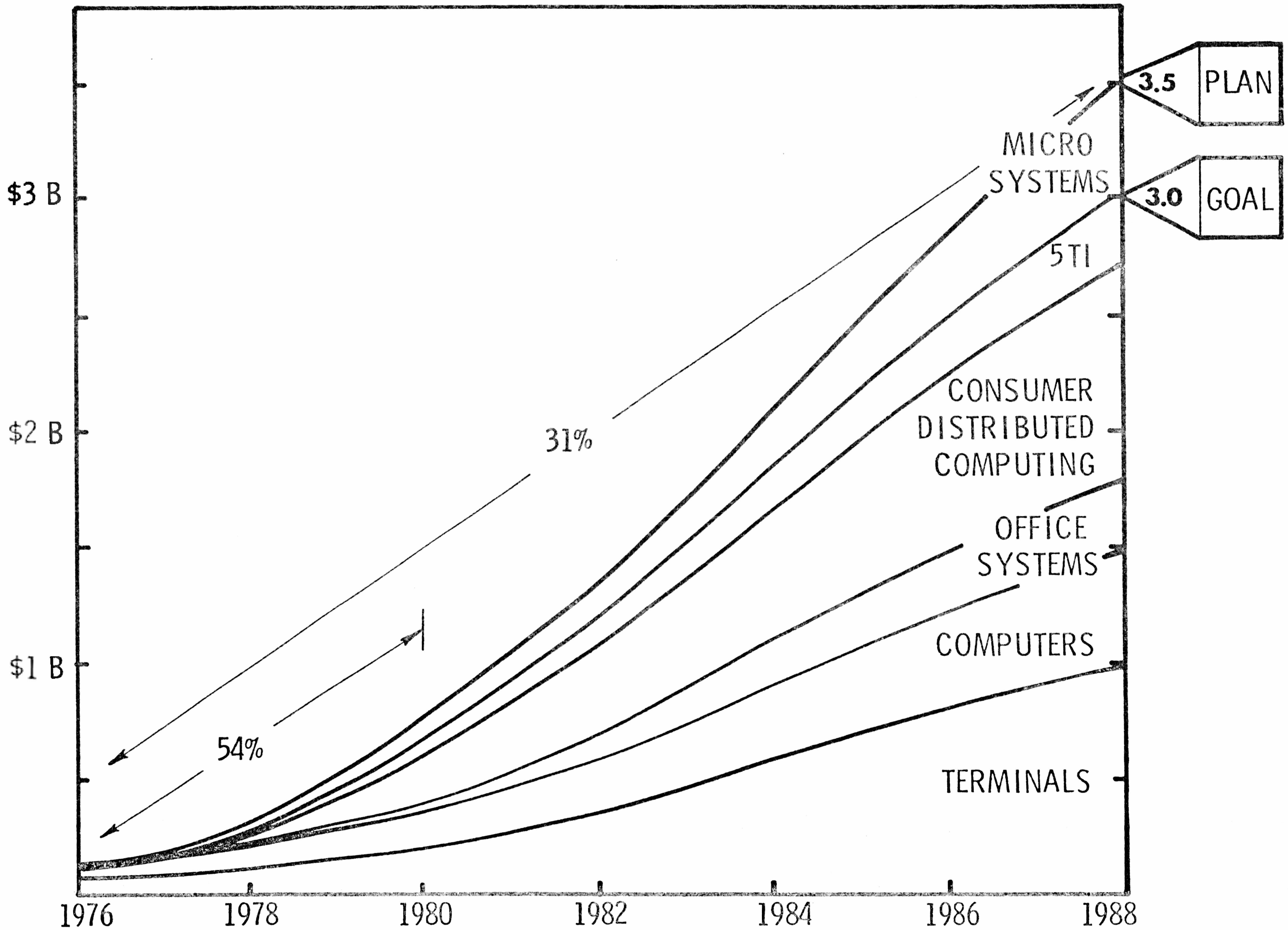
DISTRIBUTED COMPUTING



Slide 31:

Combining the efforts of IS&S and DSD to solve the external market problem concurrently with the internal problem, we can develop a significant opportunity for DSD in distributed networks and business data processing--serving on a selective basis, major customers with information services needs similar to TI's.

DISTRIBUTED COMPUTING
PROJECTED NSB—LONG RANGE PLAN



Slide 38:

Consolidating the various distributed computing elements results in a 1988 NSB of $3.5 billion. This requires an annual growth rate of 31% over the period and about 54% per year between now and 1980.

But is it reasonable to target such a growth rate for a major thrust? One obvious answer is: for distributed computing to become a major thrust, in the sense it contributed 1/3 to 1/4 of our 1988 NSB, it must grow in the range of 28 to 30%.

Most of the preceding disucssion has addressed the market and leadership opportunities for TI. But clearly, achieving these growth rates means shifting OST and cash resources away from slower growing businesses of TI. We must convince ourselves whether this shift is justified.

DISTRIBUTED COMPUTING

TWO FEASIBILITY QUESTIONS

1. ARE WE GETTING ENOUGH GROWTH FROM CURRENT DISTRIBUTED COMPUTING OST INVESTMENTS?

2. ARE WE TARGETING UNSUSTAINABLE GROWTH RATES IN ANY SEGMENTS?

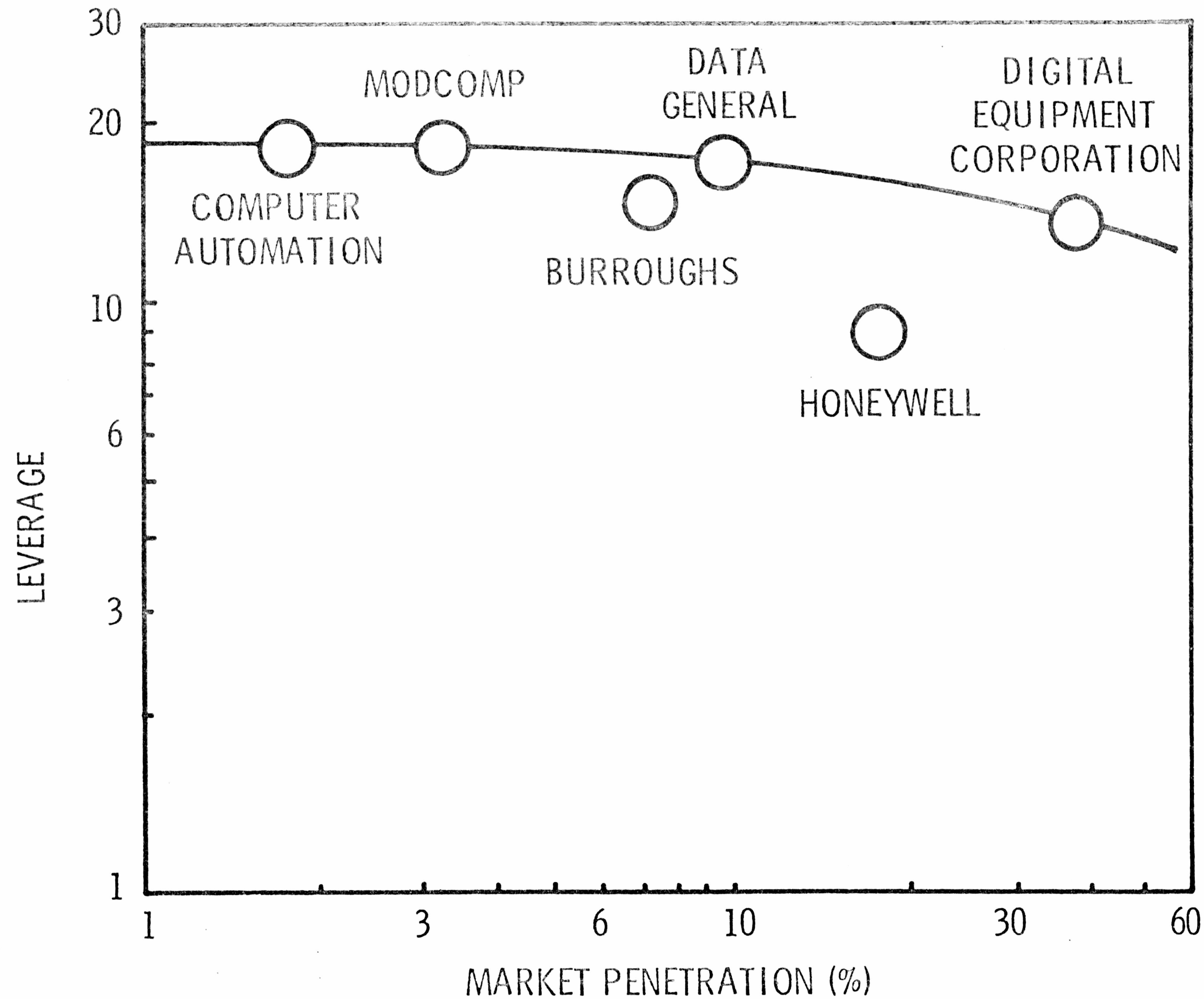
Slide 39:

To dig deeper, we asked two questions:

1. Are we getting the growth we should from our current OST investment? And,

2. Are we targeting growth rates in any segments that are clearly unsustainable?

DISTRIBUTED COMPUTING
OST LEVERAGE (1971—1976)



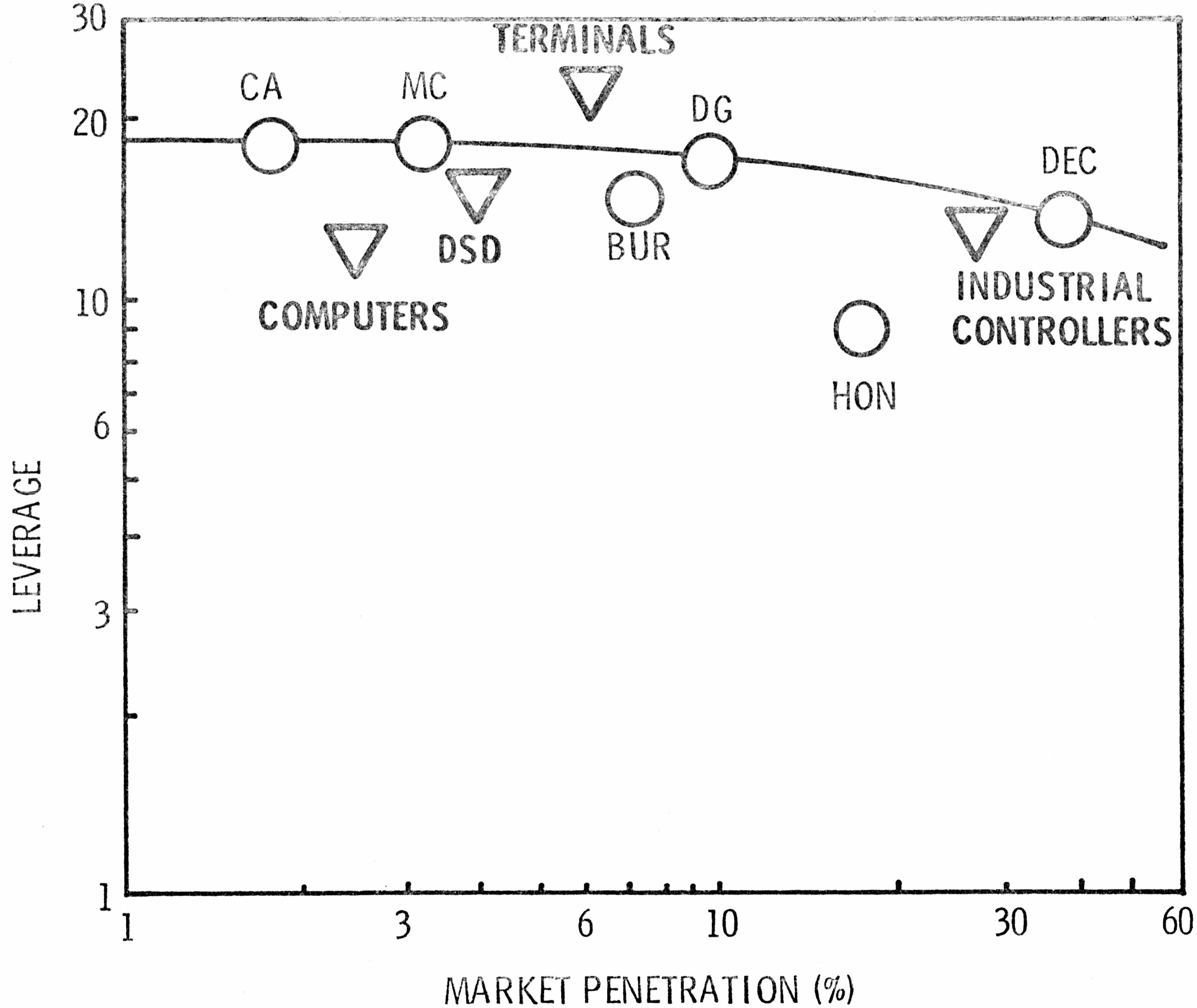
Slide 40:

To answer the first, we calculated OST leverage for a number of computer companies, using the method described Monday by Jim Fischer. Leverage measures the delta NSB growth produced by OST-like investments. It is a measure of efficiency in use of OST dollars. R&D investments from published financial data were used in the calculations.

The line connects companies selected for top ROA performance, and represents an efficiency frontier for leading edge performance.

DISTRIBUTED COMPUTING
OST LEVERAGE (1971 – 1976)

TI



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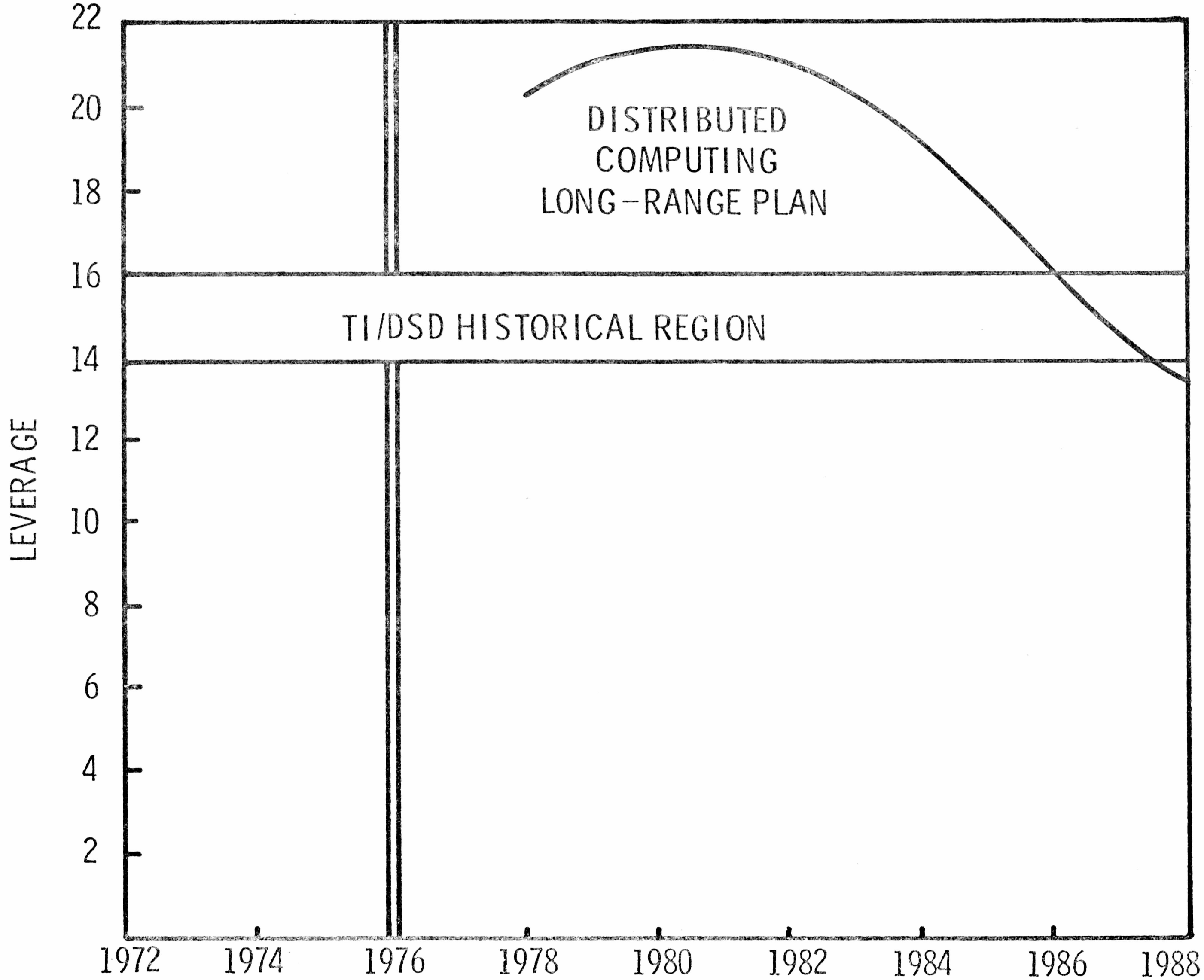
Slide 41:

OST leverage was also calculated for some key TI business entities in distributed computing. Terminals have been above the frontier, industrial controllers very near. Computers have been somewhat below, but DSD overall very ;near the frontier. Considering that the majority of companies are going to fall well below the efficiency frontier, our investments in DSD have been quite competitive. As we complete our tool building phase in computers, move into a more steady-state condition, growth can come with smaller incremental investments, and leverage in the computer business will move up. That will move DSD right up to the efficiency frontier.

Now, what leverage is required by the long-range plan for consolidated Distributed Computing?

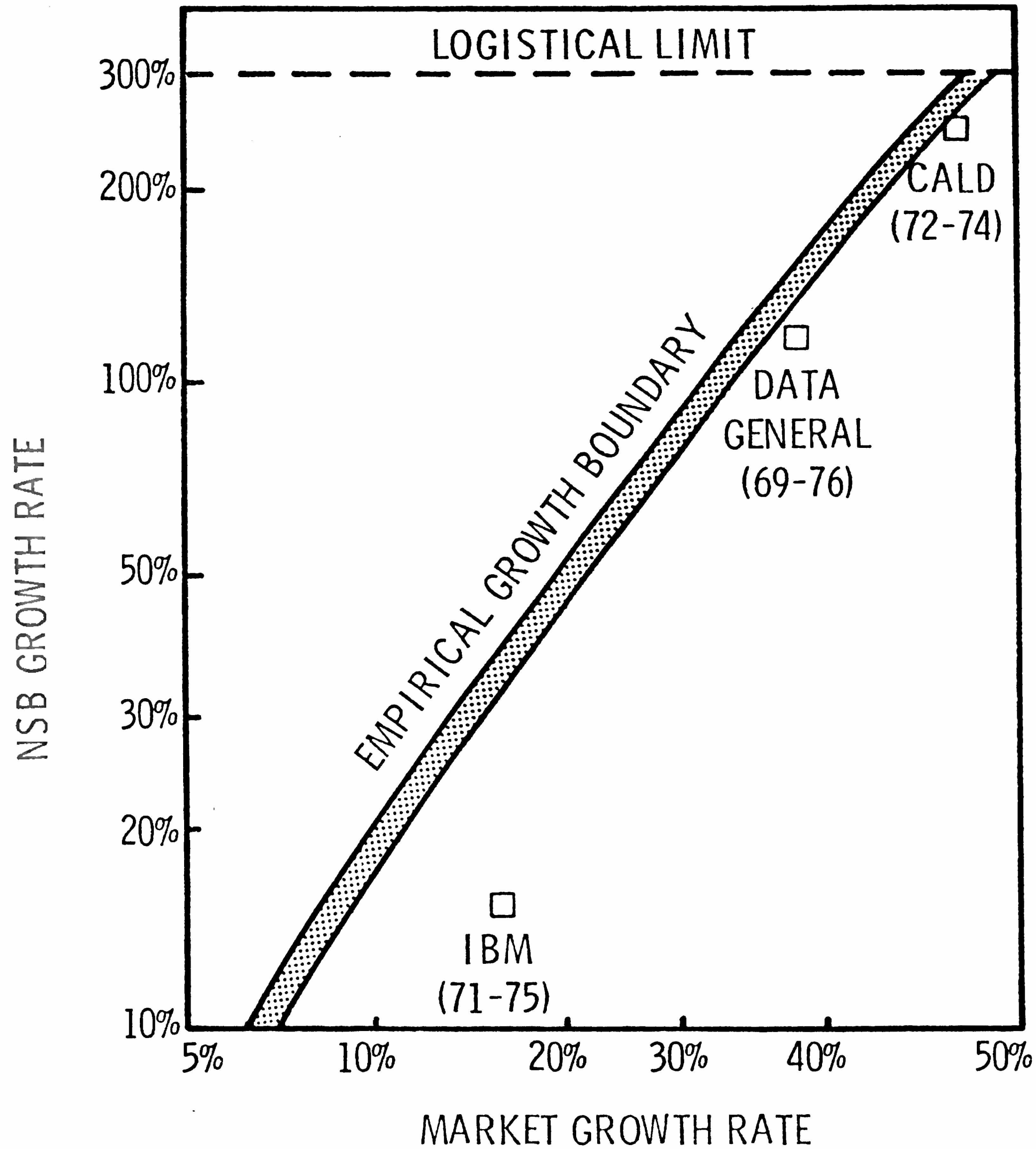
DISTRIBUTED COMPUTING COMPOSITE LEVERAGE



Slide 42:

That can be computed directly from the long-range plan. It's about 40% higher than our historical DSD performance, and at least More work is needed to refine and confirms these estimates, but 20% above the efficiency frontier./ I conclude that our historical leverage, on the average, has been pretty good, it can move to leading edge in next couple of years, but we may be generating some unrealsitic growth expectations for the near-term , with a leverage of 21 built into our plans.

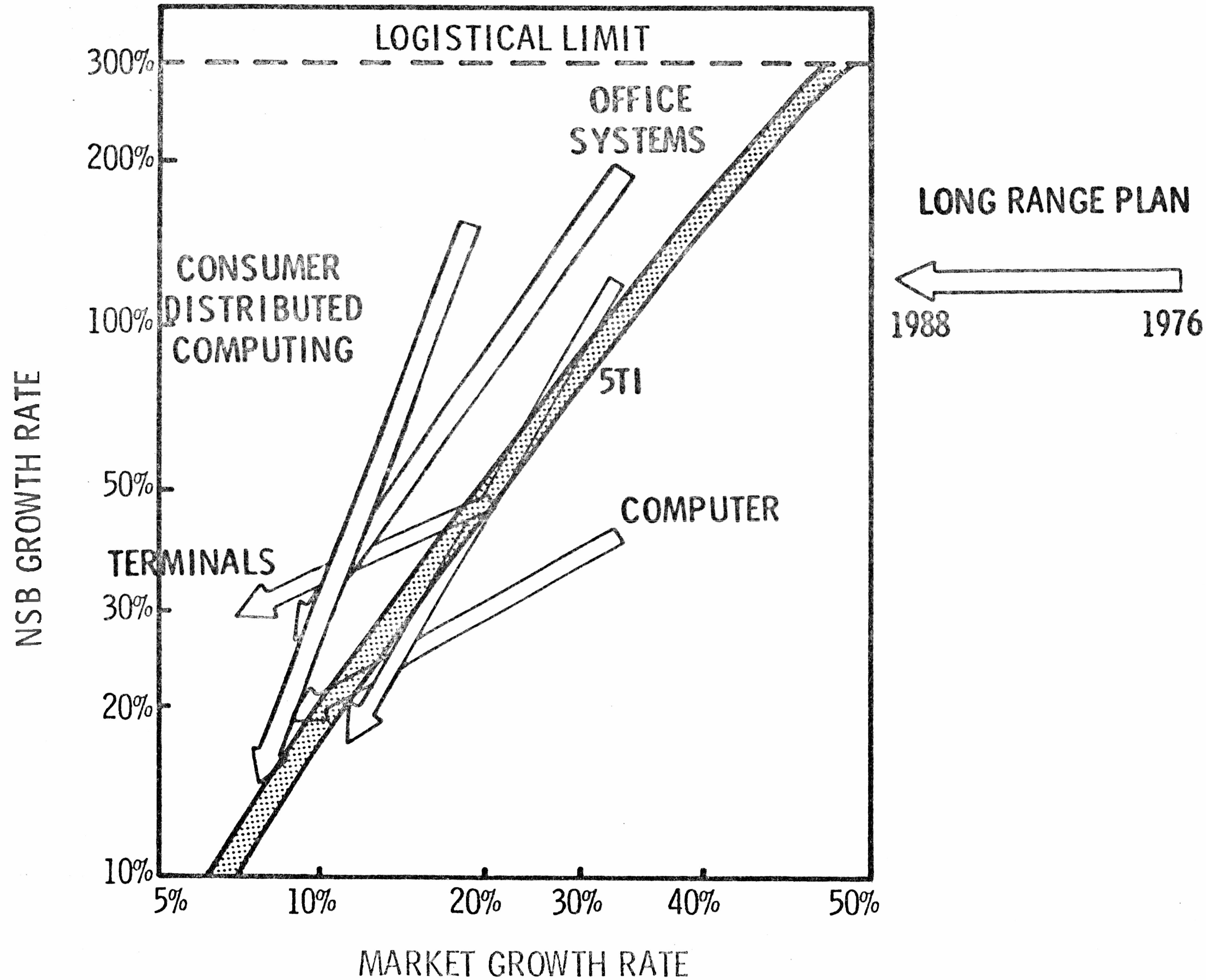
DISTRIBUTED COMPUTING
EMPIRICAL GROWTH BOUNDARY



Slide 43

Now, the second question: Are we targeting unsustainable growth rates in view of market growth and other constraints? We looked at several examples of extraordinary growth performances such as Data General and TI's CALD, and then sketched an empirical growth boundary. It represents an upper bound on how fast a business can grow, as a function of its market growth. Above the line is a red-flag region, where your business growth is very high, in a slow growth market. That possibility may exist, but only under exceptional conditions. Businesses in that region may also need to do a better job of segmenting out their grwoth target from a slowing-growing SAM. Let's test our business plans against this criterion.

DISTRIBUTED COMPUTING
EMPIRICAL GROWTH BOUNDARY

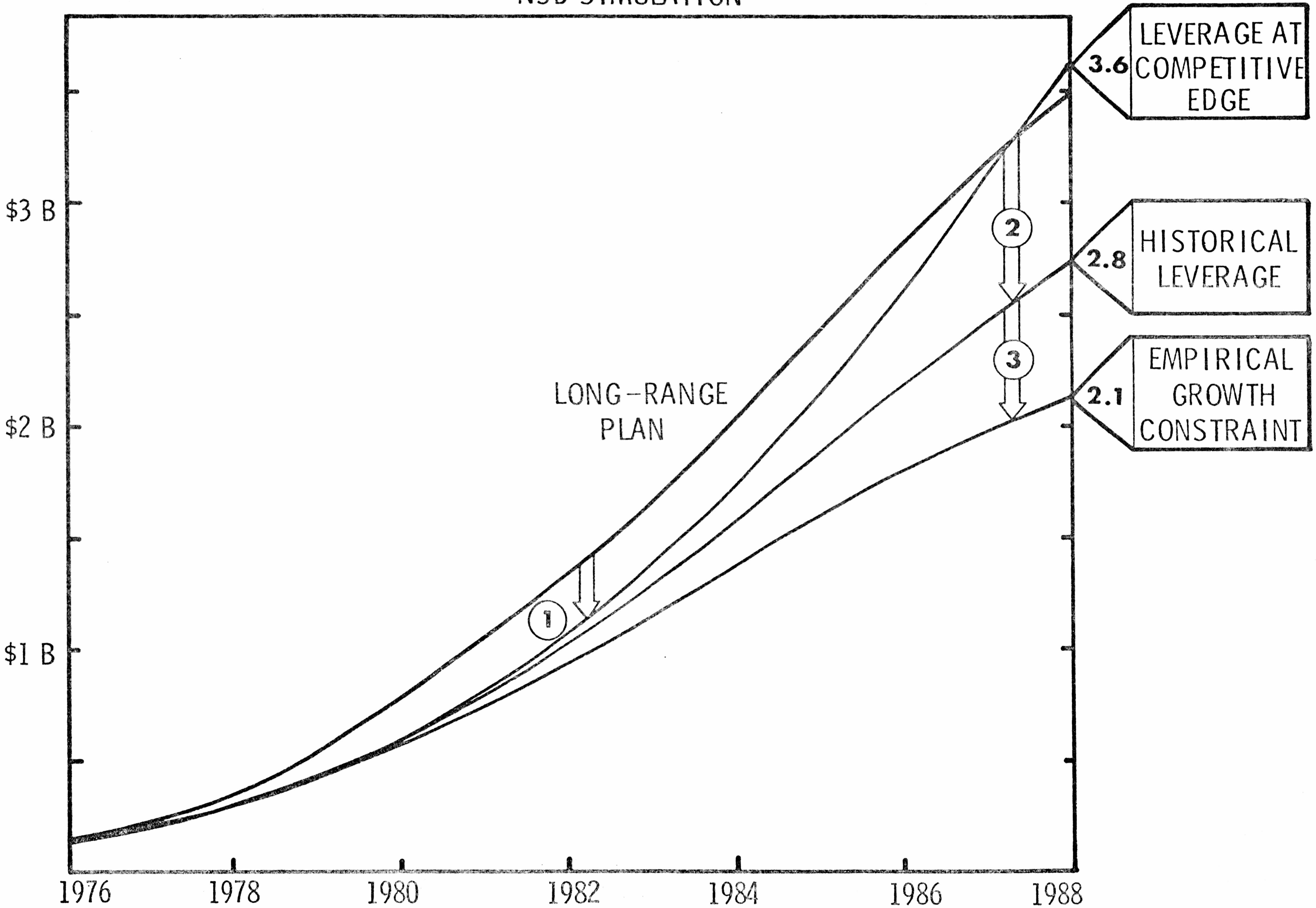


Slide 44

Here we see computers, with its family incomplete, well below the empirical limit, but moving toward it. The 5TI is near it throughout the period. Terminals, Office Systems, and the Consumer portion are in the red-flag region. Terminals starts at the boundary, and moves across. They must target an explosive segment within the market, and it could be the electronic mail terminal. Office Systems and Consumer products both have the opportunity for revolutionary growth, and can probably also target explosive sub-segments.

Then, we asked what if we only got historical OST leverage, and what if the empirical growth boundary did indeed limit these extraordinary growth rates?

DISTRIBUTED COMPUTING
NSB SIMULATION



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Slide 45

These conditions were simulated. Three key results are shown.

Item 1. With leverage at the competitive edge, we reach the plan end point, but still don't achieve the high near-term growth rates in the long range plan.

Item 2. If we achieve only historical leverage, our 1988 contribution drops to $2.8 billion.

Item 3. If the empirical growth constraint is applied, we drop further to $2.1 billion in 1988. The range from $2.1 to $3.6 billion is a rather broad range, but twelve years is also a long time.

I believe that we will move leverage up, that we will achieve at least some of extraordinary growth potential, and that the distributed computing goal of $3 billion is within our grasp and will justify the investment

It will not likely happen through a major, sudden revolution in technology.

We will need to build our strength in many evolutionary areas, and carefully choose others where TI's opportunity for innovation and leadership can be decisive.

DISTRIBUTED COMPUTING
MANDATORY EVOLUTIONS

C
 	
APPLICATION SPECIFIC PRODUCTS
	• SELECTIVE APPLICATION SOFTWARE
	    • BUSINESS DATA PROCESSING
	    • TEXT PROCESSING

B SYSTEM ELEMENTS	• PACKAGED MINICOMPUTERS • CARTRIDGE DISK PRODUCTION • PERIPHERAL INTERFACES • LOW COST CRT TERMINAL • PROGRAMMABLE TERMINALS • SYSTEM SOFTWARE
A MICROSYSTEMS	• MEMORY BOARDS • INDUSTRIAL INTERFACES • COMMUNICATION INTERFACES • SYSTEM SOFTWARE

Slide 46

Here is a checklist of what I've called the mandatory evolutions. Some may be catch-ups, others me-too's, in some we are already at the state-of-the-art. This is our offensive line. Next, let's look at our set of scoring plays.

DISTRIBUTED COMPUTING LEADERSHIP POTENTIAL

C APPLICATION SPECIFIC PRODUCTS	• PERSONAL COMPUTER • HOME COMPUTER • ELECTRONIC MAIL TERMINALS • VAM-BASED PRODUCTS • VOICE-BASED PRODUCTS • INDUSTRIAL CONTROLLERS • DISTRIBUTED NETWORKS/MULTIPROCESSOR
B SYSTEM ELEMENTS	• MASS STORAGE PERIPHERALS (ADD, BUBBLES, CCD) • LOW-COST PERIPHERALS • DOCUMENT SCANNER/OCR • INK JET PRINTER • DISPLAYS • TERMINALS WITH MASS STORAGE
A MICROSYSTEMS	• 16-BIT MICROCOMPUTERS • 32-BIT MICROCOMPUTERS • MICROPERIPHERALS

Slide 47:

TI does have a truly impressive array of leadership potential programs. Given that we execute the mandatory evolutions, I believe that we can gauge our success in distributed computing in the 1980's largely by how well we exploit these potential leadership opportunities.

We must work with the Corporate Development Committee on this list in the months ahead to make sure we fully exploit these leadership possibilities before the potential advantages erode away.

DISTRIBUTED COMPUTING
CRITIQUE

ITEM	EXAMPLES
1. MOVE 990 AND TERMINALS ACROSS THE FAMILY THRESHOLD	990 SOFTWARE 745 B CLUSTER TERMINAL
2. DEVELOP STRATEGY FOR PERIPHERALS	810, PRINTER ADD, BIGGER DISKS HIGH-QUALITY PRINTERS
3. SELECT APPLICATION SPECIFIC THRUSTS a. LEVEL 2: JOINT DSD/IS&S EFFORT b. LEVEL 3: TI TECHNOLOGY/MARKET SEGMENTATION	NETWORK COMMUNICATIONS DISTRIBUTED PROCESSING DATA BASE MANAGEMENT VAM, SPEECH, APPLICATION EXPERTISE
4. DEVELOP LEVEL 4 (UNDER $2K) CUSTOMER BASE a. PERSONAL COMPUTER b. MICROSYSTEMS	SR-70, SR-62 (BUBBLES) APPLICATION PROGRAMS MEMORY BOARDS MICROPERIPHERALS
5. DEVELOP LEADERSHIP TECHNOLOGY	MULTIPROCESSORS LANGUAGE PROCESSORS SOFTWARE ENGINEERING SELF-TEACHING USER INTERFACES

Slide 48..

Let's critique the game plan.

1. We will move the 990 and programmable terminals across the product family threshold this year. For the first time, we will have a viable minicomputer family, with the minimum critical mass to support our packaged systems thrust. This, plus moving to a more steady-state product introduction cycle following creation of the 990 family, will enhance our OST leverage.

2. We can begin shifting more investment to peripherals. We have the 810 printer now, and the ADD disk is started. But we need much more, and must get a comprehensive peripheral family strategy together before fall.

3. Then we can shift more emphasis to application specific products. Since we will be late there, we must pick latter emerging opportunities, while our competitors have their hands full of today's business. As an example, pick electronic mail terminals over point-of-sale terminals.

We have an option at Level 2:

We can market solutions to the TI-type information system problem to a selected group of Fortune-500 firms. This is a long lead proposition, but would be a sizeable opportunity, and drive TI the way we need to go.

4. We must deliberately build a TI customer base at Level 4. The personal computer is a start, but to be successful it must satisfy the user self-teaching requirement.

In microsystems we have a start, but need much more emphasis on the memory opportunity with bubble and CCD systems, and on microperipherals.

5. Finally, we need to be deliberately building technology leadership positions in specific areas like multiprocessors, software engineering, and self-teaching techniques.

Now, with a bit of tongue in cheek -- but hopefully capturing some useful insight -- I'd like to summarize the ABC strategy levels this way:

DISTRIBUTED COMPUTING

STRATEGY LEVELS A, B, C SUMMARY

A — **" THE CPU IS FREE IF YOU WILL BUY MY MEMORY . . . "**

Slide 47.:

The semiconductor people see their volume in memory, so they tend to say:

"The CPU is free if you buy my memory!"

DISTRIBUTED COMPUTING

STRATEGY LEVELS A, B, C SUMMARY

B **" THE COMPUTER IS FREE IF YOU WILL BUY MY PERIPHERALS . . . "**

A " THE CPU IS FREE IF YOU WILL BUY MY MEMORY . . . "

Slide 50

At Level B, , it tends to be,

"The computer is free if you buy my peripherals!"

Well, you can probably guess what comes next at Level C!

STRATEGY LEVELS A, B, C SUMMARY

C **"THE HARDWARE IS FREE IF YOU WILL BUY MY SOFTWARE . . ."**

B "THE COMPUTER IS FREE IF YOU WILL BUY MY PERIPHERALS . . ."

A "THE CPU IS FREE IF YOU WILL BUY MY MEMORY . . ."

Slide 51 :

We don't really expect CPU's computers, and all hardware to become free -- but this does remind us that the most decisive elements are going to be memory, peripherals, and software.

I believe Lunch is next .... Thank you.